HOW TO READ A DRAWING

Vincent C. Getty

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BY

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WITH 62 ILLUSTRATIONS

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PREFACE

The understanding of a drawing has appeared to many who are not familiar with this branch of education to be a very difficult study. It has been the writer's province to know that there are a vast number of mechanics who look upon drawings with awe, thinking that to become proficient in the understanding of drawings they first must have scholarly or technical knowledge. It is the purpose of this book to show that this is a very erroneous idea, it being a fact that this branch of education requires less study than almost any other branch of useful knowledge; and all the education necessary is, that the student be able to read and understand the English language.

As to its usefulness, I doubt if there is any branch of education that compares with it; for by drawings we can express our thoughts and desires more clearly and concisely, and they can be understood more readily, than by any other system known to the civilized world. In the commercial or industrial world no work of consequence is carried on without them, and, from the making of a special bolt to the building of a railroad, drawings are necessary.

Who then, realizing this, can afford to be without this knowledge? Surely not those whose wages are small, for their wages will always be small unless they acquire useful knowledge which will tend to better their conditions in life; surely not those in the higher stations of life, for unless they understand drawings they must depend solely upon some one else who has this knowledge, in order that their desires may be carried out. The manager, purchasing agent, superintendent, foreman, mechanic, clerk, shopman, or laborer, will find this knowledge to be a stepping-stone toward success.

In this book it has been my endeavor to explain the reading of a drawing without the use of technical terms; but where

it has been absolutely necessary to use such terms, their meaning has been fully explained.

I also wish the student to understand that, while I have divided the different classes of drawings under different headings, this work should be studied as a whole; as failure to understand thoroughly any part of it may result in a misunderstanding of it all.

The main principles of drawing have been thoroughly explained and sufficient examples given to enable any one to understand clearly any drawing; but I want to impress upon the student that, in order to master it, he must study it carefully and conscientiously, for, in the words of a great philosopher, "Nothing great is accomplished without an effort."

In conclusion, I want to add that, while this book was written with the intention of helping many, if it helps a few I shall be repaid.

CONTENTS

HOW TO READ A DRAWING

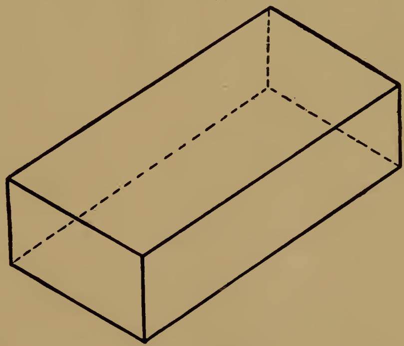
CHAPTER I

Method of Representing Objects

It is my intention to explain in this work the method by which an object may be described by a drawing.

The branch of drawing about to be explained is known as Projection Drawing, as projection drawing not only enables those who are familiar with it to know exactly what the object represented looks like, but also shows the object in such a manner that the surface or any line or angle of the object can be readily measured on the drawing.

Fig. 1.



Perspective view.

There is, however, another branch of drawing, called Perspective Drawing, that is very useful in showing what an object looks like, but would be of very little use to those who wish to construct the object so represented. Even those who are thoroughly familiar with perspective drawing would have great difficulty in measuring or determining the size of the object represented, for, while they might know positively that the two ends were of the same size or that the tops or bottoms were the same, yet, if they were to measure on the drawing either of the two ends, or the top or bottom of the object, they would find that they are there shown to be of different dimensions.

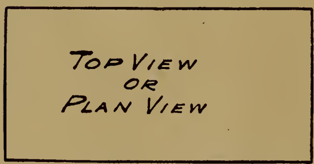
This is clearly shown in Fig. 1, it being a perspective drawing of a rectangular object, similar in shape to an ordinary brick.

This figure represents the rectangular shape as it actually appears to the eye when looked at from a certain position. In this drawing three sides of the object are shown and the other three sides are hidden, but in projection drawing only one side is usually shown, the other sides being hidden.

HOW OBJECTS ARE SHOWN BY PROJECTION DRAWING

Suppose we were to place a brick or some other rectangular object, with one of its largest sides down, upon the top of a table, or the floor of a room, or any other flat surface; then, if we were to stand so that we could look down upon it with the eye directly above it, the outline of the top of the object would appear to the eye as it is represented in Fig. 2. As we were then looking at the top of the object, this view would be known as the TOP VIEW, or PLAN VIEW, as it is sometimes called.

FIG. 2.



Rule. — A drawing which represents an object as if it were resting upon the top of a table the floor of a room, or any other flat surface, the observer looking directly down upon it from above, is called a TOP VIEW or PLAN VIEW.

If we were to look directly at the side (long side) of the object, with the eye at the same level as the top of the table upon which the object is resting, the outline of the side of the object would appear to the eye as it is represented in Fig. 3. As we were then looking at the side of the object, this view would be known as the SIDE VIEW, or FRONT VIEW, or, as it is sometimes called, SIDE ELEVATION.

Rule.—A drawing which represents an object when observed directly from the side, with the line of vision upon the same level as the top of the table upon which the object is resting, is called the SIDE VIEW or SIDE ELEVATION.

Let us now turn the object around so that its small side,

or end, can be viewed from the same position that the large side was viewed from; then, viewing this small side or end in the same manner in which we viewed the large side, it will appear to the eye as it is represented in Fig. 4. As we were then looking at the end of the object, this view would be known as the END VIEW or END ELEVATION.

FIG. 3.

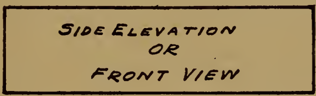


FIG. 4.

Rule.—A drawing which represents an object when observed directly from its end, with the line of vision upon the same level as the top of the table upon which the object is resting, is called an END VIEW or END ELEVATION.

The manner in which the top, side, or end of an object is shown has now been explained, but there is another view to be shown, namely the bottom view.

FIG. 5.

Let us now imagine that our object has been turned over so that it rests upon one of its sides; the bottom view would now be visible; then, by viewing it in the same manner in which the side was viewed, the bottom view would appear to the eye as it is represented in Fig. 5. As we were then looking at the bottom of the object, this view would be known as the BOTTOM VIEW.

It may be well to state here that sometimes the end or the side view of an object could be considered the front or the rear of an object; when this occurs, the view shown would be known as FRONT VIEW or FRONT ELEVATION, or REAR VIEW or REAR ELEVATION.

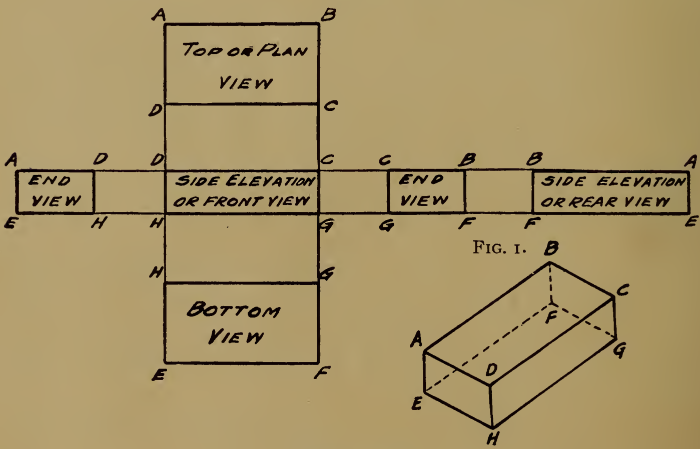
In Fig. 6 the different views are placed in their proper positions—that is, top view at the top of the drawing, end views at each end of front view, side view or front view in the

centre, bottom view at the bottom, and view of rear side at the extreme right-hand side of the drawing.

For convenience, I have repeated Fig. 1 on this page, it being a perspective drawing of Fig. 6; also the corners of the object are marked with letters of the alphabet; these letters correspond with the letters in Fig. 6. This was done in order that the different drawings may be readily compared.

In Fig. 6 the letters A, B, C, D represent the Top View or Plan View of the object shown in Fig. 1; D, C, H, G repre-

FIG. 6.



Different views.

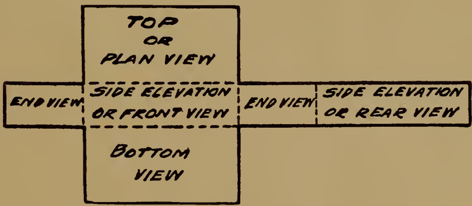
sent the Side View or Side Elevation, or, as it is sometimes called, the Front View or Front Elevation; A, D, E, H and C, B, G, F represent the ends of the object, which would be known as the End View or End Elevation; H, G, E, F represent the bottom view, and A, B, E, F represent the Rear View or Rear Elevation of the object.

As there are six sides to our object, it will be noticed that in Fig. 6 all the six views are shown; all of these views are not absolutely necessary in this case, as the object represented is very simple in construction; but all the views are shown in

order that the student may see the manner in which all the surface views of any objects may be represented by projection drawing. In order that the student shall clearly understand why these different views are shown in this manner, I give another illustration in Fig. 7.

Fig. 7 shows the different views seen in Fig. 6, joined together. In order that this illustration may be thoroughly understood, I wish to have the student cut out of cardboard a figure similar to the one shown by the heavy lines of Fig. 7, then, by bending the cardboard where the lines are dotted, the cardboard will form the figure of a rectangular object similar to the one shown in Fig. 1. This then will give the student a practical example of why the views are shown by the method used in Fig. 6.

FIG. 7.



Cardboard diagram.

To be able to understand how to read a drawing, the whole secret lies in being able to see in the mind what the object represented looks like; for in projection drawing the object is not represented as it is shown by a photograph, for in a projection drawing you see only one view at a time, and the student must remember that the view shown represents the outline, or profile, of the object; and every line that represents the form or shape of the object is shown exactly as it would appear to the eye if the eye was at a point directly facing the object.

Therefore, study carefully every word of this chapter, for if the student clearly understands all that is contained in it he will have mastered the fundamental principles of how drawings are read and the balance of this study will be found to be very simple.

CHAPTER II

Lines used in Projection Drawing

There are several kinds of lines used in projection drawing, the ones commonly used are as follows:

The full line ________________________

The dotted line ----------------------------

The dash and dotted line ______ . . ______ . . ______

The light full line ________________________

The full line is most employed, it being used to draw the outline and all parts of an object which can be seen with the eye.

The dotted line consists of a series of very short dashes, and is used to show that part of an object that is not visible to the eye; for instance, in Chapter I, page 10, Fig. 1, the edge or outline of the object marked by the letters B and F, E and F, and F and G cannot be seen by the eye; thus these edges are shown by the dotted lines. This rule of showing invisible parts of the object by a dotted line is always used in projection drawing.

The dash and dotted line is used to indicate centre lines of an object, or to show from what points a section has been taken. The use of this line will be fully explained later.

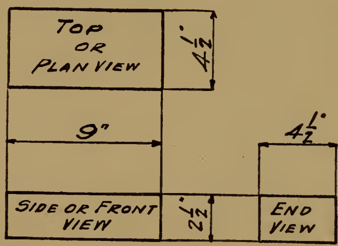
The light full line is used for showing dimensions on a drawing (that is, the distance from one point to another); sometimes, however, the dash and dotted line (______ . . ______) is used for this purpsoe, as it serves to prevent the dimension lines from being mistaken for the full line which is used to show the outlines of the object, but, as a general rule, most dimensions are shown by the light full line. The student will soon learn to distinguish the different lines, so that no mistakes or confusion will result. Any other lines not shown here will be fully explained when the necessity for using them arises.

In Chapter I (page 10) it has been stated that all the views shown were not absolutely necessary, as the object was very simple in construction, and they were given merely to show to the student the proper location of the different views by which difficult objects may be represented. In this chapter it will be explained why all these views were not necessary.

In Fig. 8 this same object is shown by only three views,—namely, top view, end view, and side view. In this figure dimensions and dimension lines are shown, which will help to explain why these three views are sufficient to show the object properly. At each end of all the dimension lines is placed an arrow point (——>). This symbol is employed to show from what points the dimensions are taken; the dimension lines are light full lines about one-half the thickness of the outlines of the object.

In this drawing it will be noticed that two small marks (″) are placed after the figures. These two marks are used to denote inches; when only one is used (′) it denotes feet; thus 1′–2″ is read one foot and two inches; 10′–3½″ is read ten feet and three and one-half inches. This method is universally used to represent feet and inches on all drawings; thus, the top view of Fig. 8 shows the object to be nine inches long by four and one-half inches wide, the side or front view shows the object to be of the same length and two and one-half inches deep, the end view also shows the same dimension for the width that is shown in the top view. While this latter dimension is not absolutely necessary, it helps the student to see at a glance that it is an end view, as the dimension showing the width of the top is the same dimension as the width in the end view.

Fig. 8.

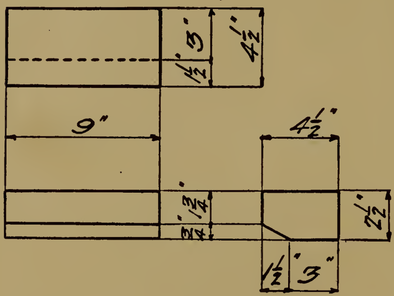


It will be seen now that these three views are all that is necessary to properly show the construction of the object, as the top view shows the length and width, the side or front view the depth, and the end view the shape of the ends. As these views show the object complete, no others are necessary, for when the top of an object is shown the bottom is always understood to be the same unless some other view shows that the bottom is different; also when one side or end of an object

is shown the other side or end is regarded as the same unless some other views show that they are different. This perhaps can be more clearly understood by referring to Fig. 9.

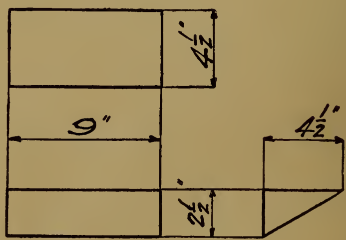
Fig. 9 shows an object similar to the one pictured in Fig. 8, except that the bottom corner of the front of the object has been cut off. This cut-off is shown by the top view and front view to extend the entire length of the object. The top view and side view show that the cut begins 1½" back from the front and ¾" up from the bottom; in the top view the exact point where this cut starts, not being visible to the eye, is shown by a dotted line. In the front view the point where the cut starts being visible, it appears as a full line. The end view shows the shape of the object very clearly.

FIG. 9.



This brings me to the point where I desire emphatically to impress upon the student the necessity of looking at all the views of the object that are shown before determining what the object really looks like. For example, in Fig. 10 the top view and side or front view are the same as the top and side views of Fig. 8. The end view, however, shows that the shape of the object is different, it having a wedge-shape instead of the rectangular shape shown in Fig. 8. Thus it will be seen that all views of the object must be taken into consideration before determining what the object represented really looks like.

FIG. 10.

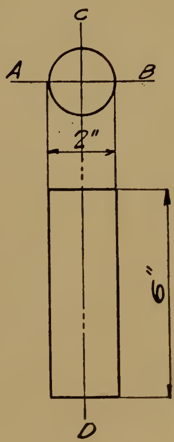


CHAPTER III

Views Needed

In all practical projection drawings only those views are shown which will actually describe the object; for instance, in Fig. 11 is represented a cylinder. The lines marked A B and C D are known as centre lines. In this drawing only two views are necessary to describe the object properly. The upper view shows that the top of the object is circular in shape, and the dimension 2″ shows the diameter. Now, if we know that the top is circular and that the object is a solid body, all that remains for us to know is the depth, for every solid circular body must have a depth. By looking at the lower view, which is projected from the centre lines A B, we see that the object is 6″ deep. Thus the views which are shown are sufficient to describe this object properly.

Fig. 11.



There is one other view which we must take into consideration, and that is called the Sectional View, or section of an object. This view is often of great help in determining exactly what an object looks like at a point where it can not be shown prominently by either top, bottom, side, or end views.

Fig. 12 represents an object similar in shape to a spool. The top view shows that the object at its ends, or at the top and bottom, is circular, the outer circle denoting the extreme diameter; the intermediate circle is that portion which is not visible to the eye when looking down upon it from above, and the inner circle denotes the size of the hole which runs through the object. The elevation, or front view, shows the outlines of the object as they appear when looking at the object as though it were resting on one of its flat ends. The dotted

lines indicate the hole which runs through the object, but which is not visible to the eye.

Fig. 13 represents the same object as above described, but instead of a side view or side elevation a section has been taken through the centre line A B,—that is, the spool is imagined to be cut in half lengthwise, and that part which is toward the front removed; then it is looked at in the same manner as if it were a front view or front elevation, but in order to

FIG. 12.

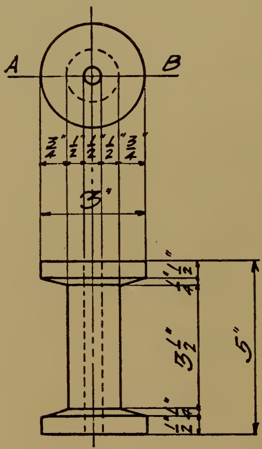
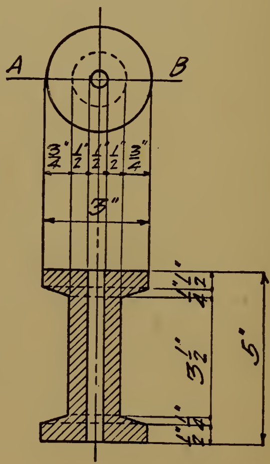


FIG. 13.



distinguish it from any of these views the section lines are employed. These lines are simply light lines drawn at an angle inside of all the outlines.

The student should by this time be familiar with the method by which simple objects are shown by projection drawings, and also with the main principles by which any object may be shown. However, there are many other minor points which shall be fully described as we proceed.

CHAPTER IV

Universally Used Structural Shapes

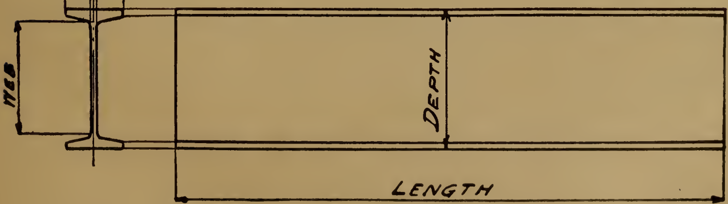
The following chapter is designed with the purpose of briefly showing and describing the various structural shapes which are universally used in the construction of buildings, bridges, etc.

Fig. 14.

Fig. 14 represents the top, end, and front views of what is known as an I Beam. This shape derives its name from the fact that the end view resembles the capital letter I.

The end view of Fig. 14 shows the shape of the I beam, the front view represents the depth and length of the beam, and the top view shows the length of the beam and the width of the flange. In the end view the top and bottom portions of the figure are known as the flanges, and that portion between the top and bottom flanges is known as the web. As will be seen, the front view or length is represented by two upper and two lower lines, being projected from the sharp corners of the flange shown in the end view.

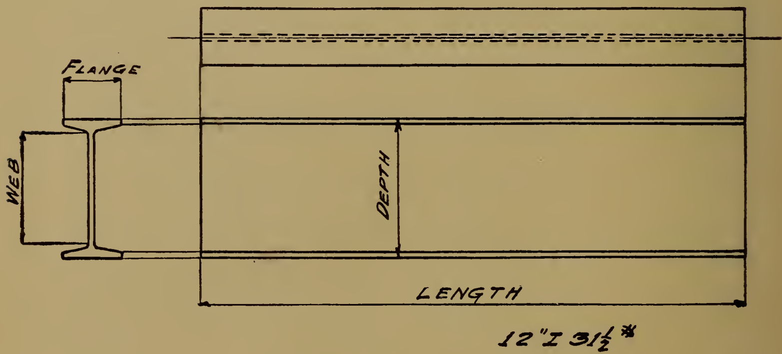
I beams are rolled to various sizes and weights; these sizes and weights are given in hand-books which are published by manufacturers of this material. I beams are generally known by the depth of the beam and weight per foot.



12" I 31½#

Fig. 14 represents a 12″ I beam weighing 31½ pounds per foot; this is generally written 12″ I 31½ lbs. The outlines of the top view indicate the top flange, and the two dotted lines represent the web. The method of projecting the top view or flange from the end view is illustrated in Fig. 14, it being shown in a perpendicular position, but, as this method of indicating the top view takes up considerable space on a drawing, the form generally used is that seen in Fig. 15. Here,

FIG. 15.



the top view is drawn immediately above the front view in a horizontal position, instead of a perpendicular position as is shown in Fig. 14.

Fig. 16 represents what is known as a channel. This shape or section is similar to the I beam, except the flanges, which do not extend over the web on one side. This shape is also rolled to various weights and sizes; the size shown in Fig. 16 is 10″ deep and weighs 15 pounds to each foot; this is generally written 10″ ⊏ 15 lbs. The end view of Fig. 16 shows the shape of this section.

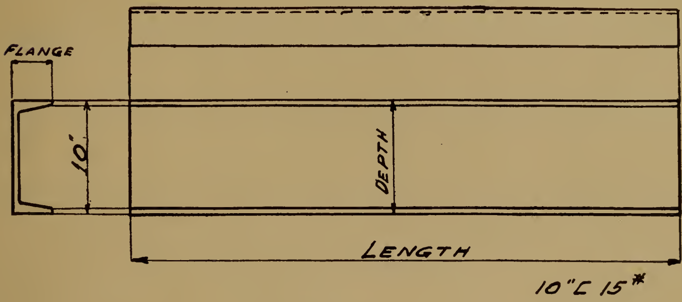
The front view is projected from the end view in the same manner as is shown in Figs. 14 and 15.

The top view represents the top flange. The first line directly above the front view shows the outer edge of the

flange, the dotted line indicates the face of the web, and the next full line represents the back of the channel.

Fig. 17 represents an angle. This shape or section is also rolled to various sizes and weights. It is, however, generally known by the size of its legs,—*i.e.*, the distance from the corner

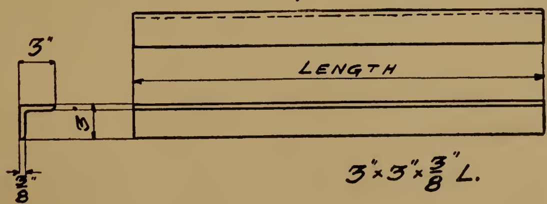
FIG. 16.



or back of the angle to the extreme edge of the leg, and the thickness of the metal of which the angle is composed.

Fig. 17 shows a 3″ x 3″ x ⅜″ angle, which is generally written 3″ x 3″ x ⅜″ L. The top view is above the front view, and is represented in the same manner as the top view of the

FIG. 17.



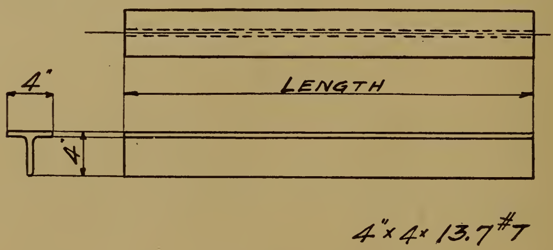
channel shown in Fig. 16, but we distinguish it from a channel by the end view, which clearly shows the shape of the angle.

In this illustration we have a practical example of why all the views shown must be taken into consideration before we know positively what the object represented really is.

Fig. 18 represents a T bar or T shape. This shape is known by the size of the legs and the weight per lineal foot. Fig. 18 shows a 4″ x 4″ x 13.7 lbs. T. As the thickness of the metal varies in the legs of the T, the weight per foot is given. This shape gets its name from the fact that the end view resembles the capital letter T.

The top view is projected from the end view by the same method as that used in showing the projection of the I beam, as illustrated in Fig. 14, but for convenience, as explained before and as is shown in Fig. 15, this view is placed directly above the front view. This brings me to the point where I must explain that the different views of an object may be

FIG. 18.

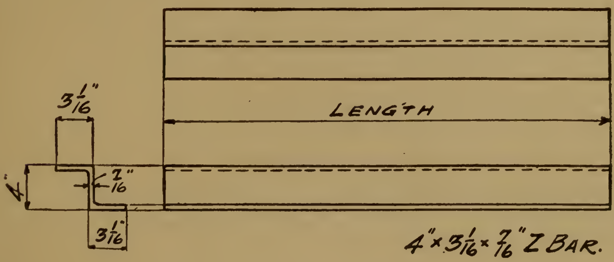


placed in any position to suit the convenience of the draftsman, but those which are not in their regular position (see Fig. 6) should be so marked as to show which view they represent. However, a view is sometimes placed out of its regular position without being so marked where it is apparent for various reasons that it could not be taken for any view other than the one intended.

Fig. 19 represents what is known as a Z bar, which derives its name from the fact that the end view resembles the capital letter Z. This section or shape is generally known by the depth (4″), width of the flange (3 1/16″), and thickness of metal (7/16″). This is generally written 4″ x 3 1/16″ x 7/16″ Z bar. The sizes and weights of all Z bars are shown in detail in any of the handbooks published by the manufacturers of this product.

The views are shown by the same method used in the other illustrations. While the above illustrations by no means cover all the different shapes manufactured or used in the construction of buildings, bridges, etc., yet I have shown the

FIG. 19.



main shapes that are used for general construction purposes, and in the following chapters will be shown some of the methods by which these shapes may be assembled to form the various members used in construction work.

CHAPTER V

Scales used in Drawing

In making drawings and likewise in the understanding of drawings, there is a factor which we must take into consideration, and that is what is known as a scale. A scale is an instrument which is used to measure distances on drawings.

The student of course knows that it is impossible to make drawings of the full size of very large objects; so where it is desired to make a drawing smaller than the object, a scale is used to measure distances instead of the standard ruler. For example, a drawing one-fourth of the natural size of an object one foot long would be made only 3″ long, because 3″ are one-fourth of one foot; therefore, on the drawing 3″ would be equal to one foot or 12″. This is known in drawings as a scale of 3″ to the foot, or, in other words, a scale which is made or graduated to 3″ to the foot is simply a ruler by which 3″ are equal to 12″ of the standard rule.

A drawing, however, may be made to any scale desired: for instance, if it were made one-fourth size, it would be known to be to the scale of 3″ to the foot; if made one-eighth size, it would be known as 1½″ to the foot.

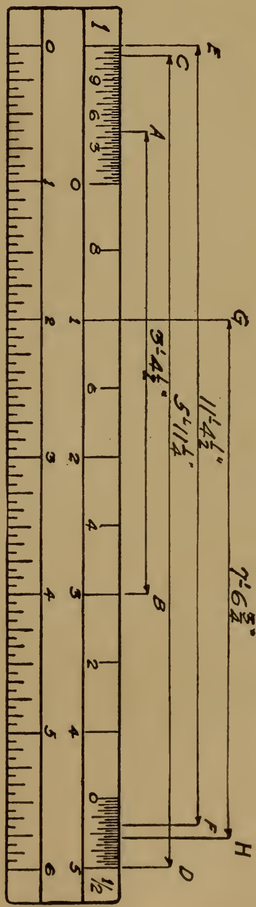
1/12 size would be equal to 1″ to the foot.
1/16 size would be equal to ¾″ to the foot.
1/24 size would be equal to ½″ to the foot.
1/32 size would be equal to ⅜″ to the foot.
1/48 size would be equal to ¼″ to the foot.

When a drawing is well made, the scale to which it is drawn is usually marked under the title of the drawing, and is generally written in the following manner: 3″=1′–0″ or 1″=1′–0″, etc.

Scales are usually made 6 inches and 12 inches long, and in shape are either triangular or flat. A scale 6 inches long is shown slightly reduced in Fig. 20. One edge is divided or graduated the same as the standard ruler,—that is, into inches,

half inches, quarter inches, eighths of an inch, and sixteenths of an inch. This scale is used in the same manner as the ordinary ruler, or for making full-sized drawings.

FIG. 20.



The other edge contains two scales,—namely, 1″ to the foot and ½″ to the foot. These sizes are indicated at the ends of the scale in large figures. In the inch scale, starting from the left end of the scale and reading toward the right, this being the scale of 1″ to the foot, each inch is equal to one foot or 12 standard inches.

The first (standard) inch is divided first into four equal parts, each of which represents one-fourth foot or three inches; for convenience in reading the scale, these divisions are marked with the figures 3, 6, and 9 and represent respectively that number of inches. By this then we see that we can measure in inches any part of a foot. Each of these inches is divided into four parts, each part representing one-fourth of one inch, and, if so desired, each one-fourth inch may be again divided to represent one-eighth of an inch. Thus it will be seen that with a scale which is so graduated that 1″ is equal to 12″, or 1′0″, we are able to measure inches or any part of an inch down to one-eighth of an inch.

Now, starting at, and on the same line as zero (0), each inch reading toward the right represents a foot. Thus, if we wish to measure 3′ 4½″, it would be the

distance between the points A–B in Fig. 20, or 5′ 11¼″ would be the distance between the points C and D in the same figure.

Starting from the right-hand end of the scale and reading toward the left, we find that it is divided or graduated to suit ½″ to the foot,—that is, the first half inch is divided in the same manner as the inch at the opposite end of the scale, and each half inch reading towards the left represents one foot. Thus, if we wish to measure 11′ 4½″, it is the distance between the points E and F in Fig. 20, or 7′ 6¾″ would be the distance between the points G and H in this figure.

In drawings where all the dimensions are given, a scale should never be used, and where all the dimensions are not given, the student should be sure that the drawing is made to scale before he uses the scale to determine definitely what the dimension is that is not given. When the scale to which a drawing has been made is not given, a good way to find out the scale of the drawing is to measure several of the dimensions which are given, or which are known, with a scale which will fit these sizes, or dimensions, and then it can be assumed that the balance of the drawing has been made to this same scale.

CHAPTER VI

Bolts, Nuts, Rivets, etc.

Before taking up the question of "How the different members and pieces of a structure are put in place," we will consider the materials with which they are fastened together, —namely, bolts, rivets, etc.

Fig. 21 represents what is known as a square-head machine bolt with a square nut. The top view shows the shape and dimensions of the head, the elevation shows the diameter and length of the bolt, the bottom view shows the shape and dimensions of the nut.

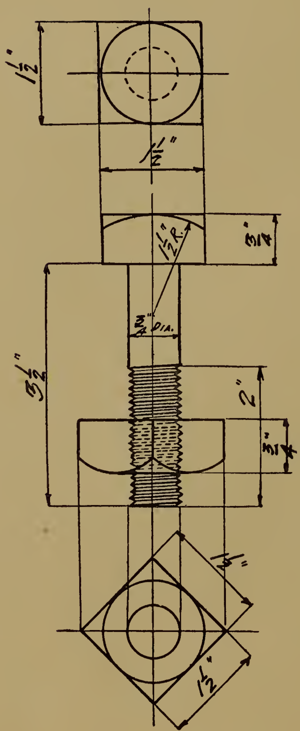
This is usually all the information that is given for nuts and bolts, for unless they are of a special make they usually conform to some well-known standard, such as Manufacturer's Standard, Franklin Institute Standard, etc. The dimensions for all the standard makes of bolts, nuts, etc., can be found in hand-books published by manufacturers of this product; in case they are of a special make, all the different dimensions and views should be shown on the drawing which represents them.

Fig. 22 represents what is known as a machine bolt with hexagon head and nut. Besides the head and nut being different from the bolt shown in Fig. 21, the thread also is different, the thread shown in Fig. 21 being that which is known as a right-hand thread (which is more generally used), while the thread of the bolt shown in Fig. 22 is called a left-hand thread.

To determine whether the thread of a bolt is a right-hand or left-hand thread, hold the bolt in a vertical position, then if it is a right-hand thread the threads will slope up toward the right hand, while left-hand threads slope up toward the left hand.

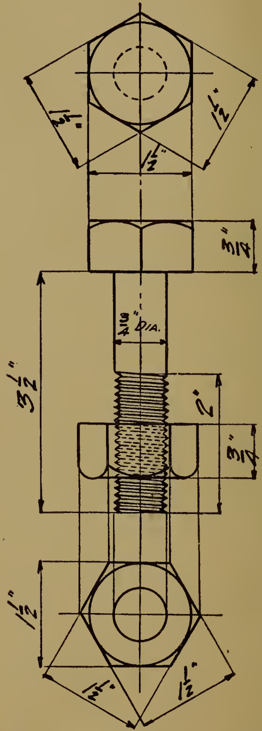
Fig. 23 represents a slotted flat-head or countersunk-head bolt with a right-hand thread. The head of this bolt is similar

FIG. 21.



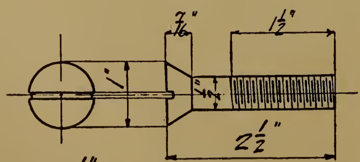
$\frac{3}{4}$" DIAMETER MACHINE BOLT, $3\frac{1}{2}$" LG.

FIG. 22.



$\frac{3}{4}$" DIAMETER MACHINE BOLT, $3\frac{1}{2}$" LG.

FIG. 23.



$\frac{1}{2}$" DIAMETER FLAT HEAD BOLT, $2\frac{1}{2}$" LG.

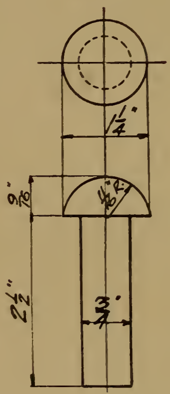
to the head of an ordinary wood screw. The method of showing this thread is also different from that employed in Figs. 21 and 22; but the method shown in Fig. 23 being more easily drawn, it is more generally used, and to those who are familiar with drawings it is as readily understood as any other method.

Fig. 24 represents what is known as a button-head rivet. The heads of this style of rivets vary somewhat in different manufacturing plants, but in shape are usually slightly less than a hemisphere.

The sizes of all rivets and bolts are known by the diameter and length; the length is always the distance under the head to the extreme end of either rivets or bolts.

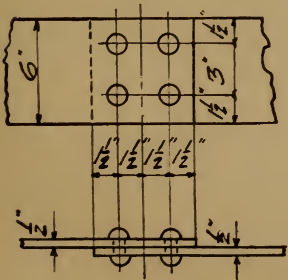
Fig. 25 represents the ends of two plates which are connected together with rivets. It is only necessary that this joint be drawn, without showing the full length of the plates, as to show the full length requires both space and labor in making the drawing, which is not necessary, as we are at present interested only in the joint. In order that we may know that the full length is not shown, the plates at the extreme right and left of the drawing are terminated by a wavy line, as though they were broken off. This wavy line indicates that the plate is not shown to its full length. If a straight line were used instead of a wavy line, it would of course indicate that the full length of the plate was shown.

Fig. 24.



3/4" DIAMETER BUTTON HEAD RIVET

Fig. 25.



Full straight lines are used to show all but the broken ends

of these plates. The other end of the bottom plate, being invisible when looking at the top view, is indicated by the dotted line; the dimension lines and dimensions are shown as was explained in a previous chapter. The side view shows how the plates lap over each other. The thickness of the plates are given and the rivets are shown to be button-head rivets.

Fig. 26 represents the method of fastening two plates together by the use of bolts.

Fig. 27 represents the method of fastening two plates together with countersunk rivets,—that is, countersunk on the top side into the surrounding material. This method is

Fig. 26.

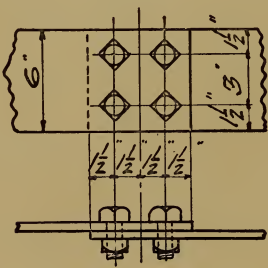
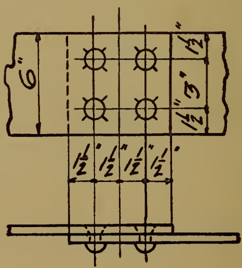


Fig. 27.



generally employed where it is desired to have a smooth surface, and where the rivet heads will not extend beyond the material which they fasten together.

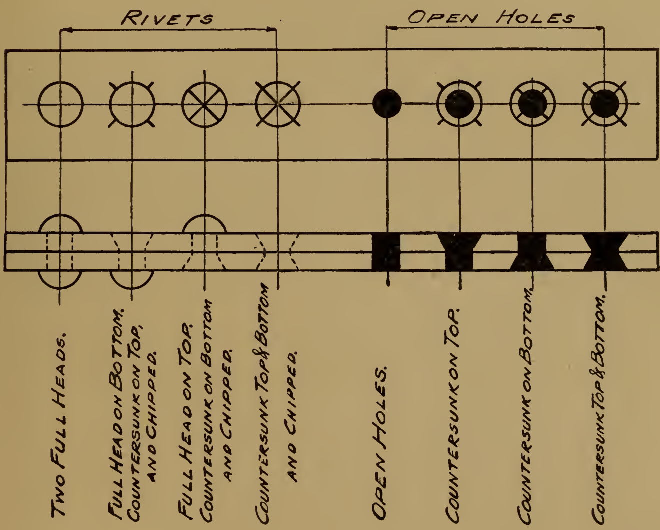
The student should now have a good idea of how the details of bolts and rivets are shown. When not otherwise indicated or noted on a drawing, all rivets are to be button-head rivets and are to be driven in the shop. When countersunk rivets are required, the open holes should be drilled out to suit the countersunk rivets which fit into them.

"Shop rivet" is the name given to rivets which are to be driven in the shop. "Field rivet" is the name given to those which are to be driven during the erection of the structure, or in the field.

"Open holes" are those which are to be left open in the shop, to suit either bolts or rivets which are to be used in the field.

In order that each different style or shape of rivet may be readily understood, the following conventional signs which are used to describe rivets have been adopted by all the leading engineers and bridge and structural shops throughout the United States.

FIG. 28.



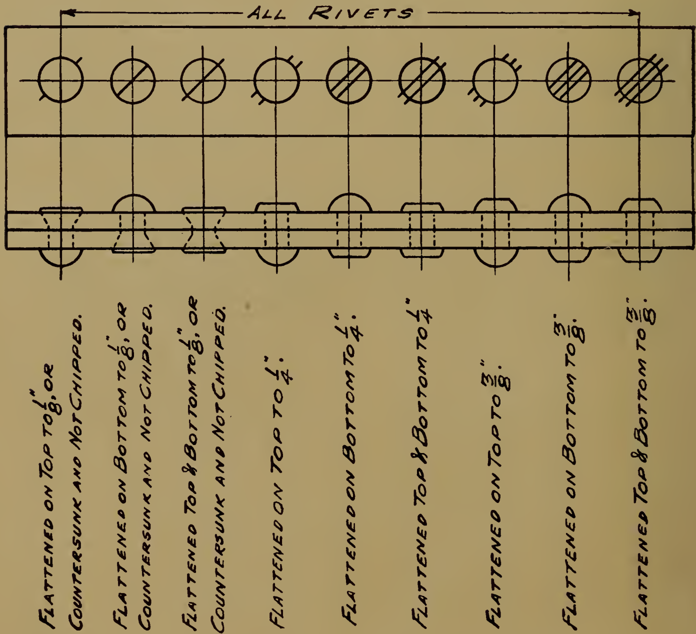
It is the usual practice to provide the open holes for rivets and bolts (where the holes are punched out or drilled out) $\frac{1}{16}''$ larger than the diameter of the rivets and bolts which fit into them.

The sizes of rivets, bolts, or open holes which are required are generally marked in some convenient place on the drawing, thus:

Open holes $\frac{13}{16}''$ dia.
Rivets $\frac{3}{4}''$ "

All the main principles of structural drawing have now been explained, and all that is required now by the student is experience, in order to become proficient; and in order to get experience in this line, I would suggest that the student secure from time to time drawings of various objects, whether of direct interest or not, and study them. Study the minor

Fig. 29.



points, and if there are any of these points that you do not understand, or that you are not sure about, or that do not seem clear to you, go to some one who does understand them, learn all about them, master them; that is experience.

The following chapters, however, are designed to explain the majority of these minor points and to make clear any that have not already been explained.

CHAPTER VII

Structural Details

Fig. 30 represents the top, front, and end views of a 12″ I beam 31½ pounds to the foot. On each end of this beam two angles 6″ x 4″ x 7/16″ x 0′ 7½″ long are shown, riveted in place, each pair of angles containing 5 rivets.

On the extreme left end this beam is square; on the extreme right the end is shown coped to fit a 15″ I 42 pounds per foot, flush on top; *i.e.*, the top flange of the 12″ beam has been cut off so that it will fit into a 15″ I beam running in the opposite direction, thus allowing both beams to be level with each other on top. The 15″ I beam is shown with light dotted lines merely, to indicate clearly why this beam has been coped. The top view of the I beam shows four open holes; at the left end of the top view is shown the distance that these holes are apart, namely 2¾″. This dimension is known as the gauge of a beam, and is generally a standard dimension for all beams of the same size. One-half of the gauge (in this case 1⅜″) is measured from each side of the centre of the web of the beam. These holes are 5′ 0″ apart (starting from either end of the beam in the opposite direction from the gauge), and these holes are also shown projected from the top view to the top flange, only, of the front view. This shows that there are no holes in the bottom flange of the beam. The connection angles are shown to be centrally located on the web of the beam; this is known because the centres of the angles are half-way, or 6″, from the top and bottom of the beam. The dimensions for the open holes and rivets are always given from the back of the angle to the centres of all holes. This is the correct way to give dimensions on angles, and the student should remember this important point. The end views are shown at both ends of the beam, and should be readily understood, without much comment. I might, however, mention that the top part of the end view, at the right-hand side of the front view, has a

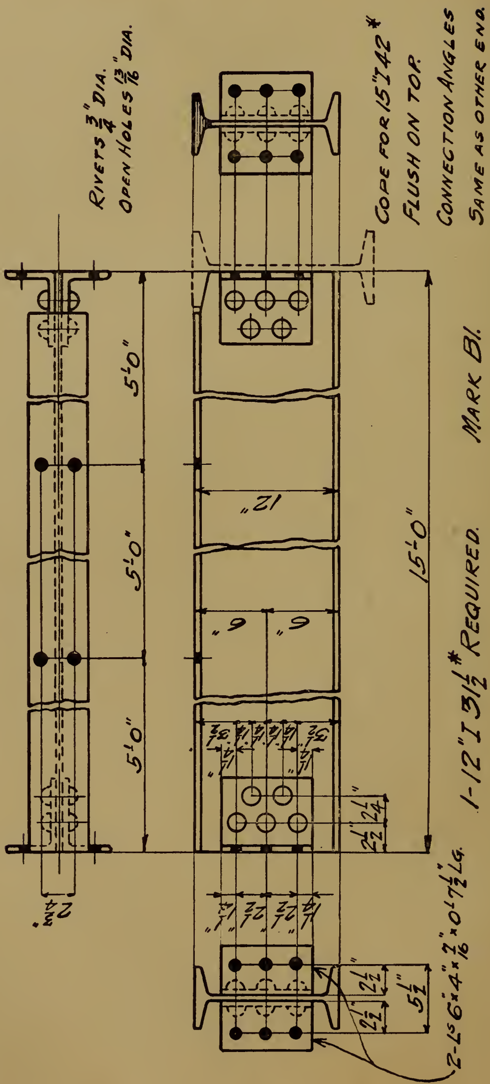

Rivets 3/4" Dia.
Open Holes 13/16" Dia.
Cope for 15" I 42 #
Flush on top.
Connection Angles
Same as other end.
Mark B1.
1-12" I 31½ # Required.
2-Ls 6"x4"x7/16"x0'-7½" Lg.
5'-0"
5'-0"
5'-0"
15'-0"
12"
6"
6"

Fig. 30.

series of light lines to show that the beam is coped. The title, "1–12″ I 31½ pounds Required. Mark B1," signifies that one beam 12″ deep, weighing 31½ pounds to the foot, is required to be finished exactly as per sketch. B1 is merely a mark which is to be written in the shop, somewhere on the beam (generally with white lead), so that the builder may be able to distinguish it from some other material he may have for erection which may resemble this beam somewhat but is not identically like it.

It will also be noticed that this beam is shown as if broken in three places; this was done in order to show that lengthwise the beam is not drawn to scale. As this beam is fifteen feet long, a full-length drawing would require very much more space, and this is quite needless, as every point is clearly shown that is necessary to properly understand what is required. This will be readily seen by the dimensions of the top view; if we were to measure with a scale any of the 5 feet dimensions, we would find that they do not measure 5 feet, and by observing that the beam was broken between each of these dimensions, we would readily understand why they were not shown the full 5 feet. Another point that must be remembered: in all drawing where a dimension is given, even if it is very much out of scale, the dimension is to be followed instead of the distance being measured with a scale, as a scale is to be used only on a well-made drawing where no dimensions are given.

Fig. 31 represents what is known as a double I beam or I-beam girder. This consists in two beams joined together by cast-iron separators and bolts. The views represented are the top view, end view, front view, and view of separators. The top view and end view show how the separators are placed between the beams and how they are held in place by the bolts; the front view shows the distance between the separators and how far they are placed from the ends of the beam. These are standard separators for this size of beam; a view of these separators, which shows their shape, is given above the end view. Complete details of separators can generally be found in hand-books issued by the steel manufacturers.

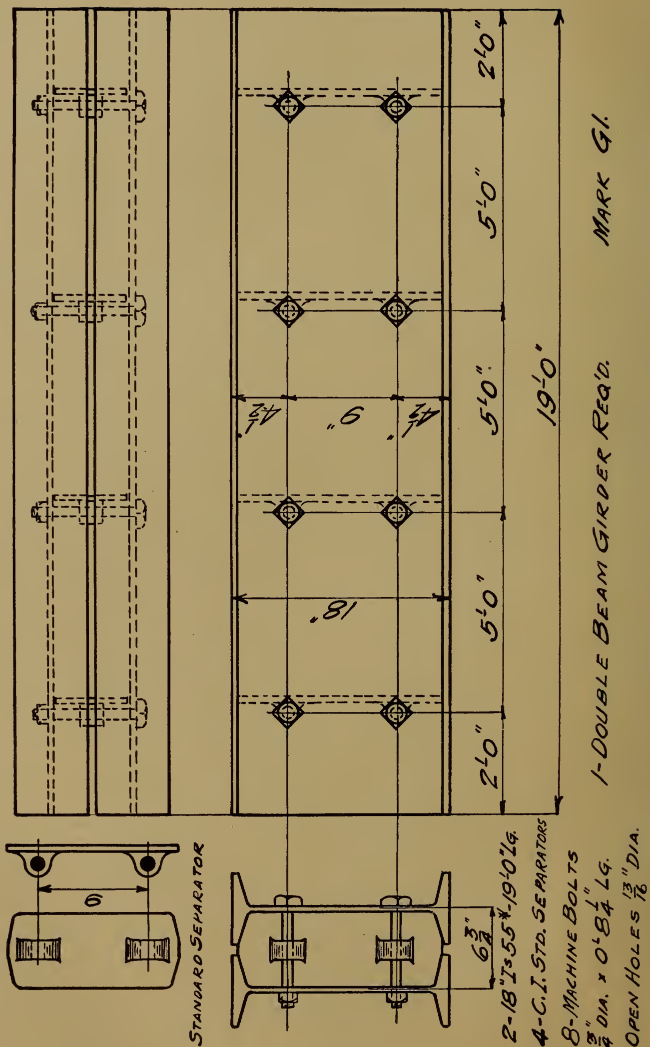

2'0"
5'0"
5'0"
5'0"
2'0"
19'0"
4½"
9"
4½"
18"
6
6¾"
MARK G1.
1-DOUBLE BEAM GIRDER REQ'D.
STANDARD SEPARATOR
2-18" I's 55#-19'0" LG.
4-C.I. STD. SEPARATORS
8-MACHINE BOLTS
¾" DIA. x 0'8¼" LG.
OPEN HOLES 13/16" DIA.

FIG. 31.

Fig. 32 represents what is known as a beam box girder. This is composed of two I beams connected together by means of a top and bottom plate, which are fastened to the top and bottom flanges of the beams by means of rivets. On the web of these beams there are riveted two sets of small angles, three to a set. In this sketch we have a number of the different elements which we will find in structural details. In the top view the heavy lines show the edges of the top plate and the dotted lines show the top flanges and webs of the two I beams. The dimensions show the distance centre to centre of the webs of the beams, also the gauge of the beams and the spacing of the rivets. The terms 13 spaces @ 1′–0″=13′–0″ simply means that the rivets are placed one foot apart and that there are 13 spaces. Sometimes on a drawing only a few of the rivets are actually shown, but the student or workman must be always guided by the dimensions when they are distinctly given. In the front view are shown the thickness of the top and bottom plate and depth of the beam, and on the left-hand side in the front view are seen three small angles which are riveted to the web of the front beam only. This is clearly understood by consulting the top view, which shows exactly on which beam these angles are riveted. On the right-hand side in the front view, in dotted lines, may be seen another group of small angles, which are the same as the angles on the left-hand side, except that they are riveted to the web of the far beam. In the bottom view the first two rivets on each end are shown to be countersunk on the bottom side. This bottom view also shows on which beam the small angles are riveted. The end view shows the general arrangement of the girder, and no further comment of this view should be necessary.

The various parts throughout are named for one complete girder, and an arrow point is shown pointing to each piece designating where the parts so named are located. The number to be furnished is two whole girders complete.

Fig. 33 represents what is known as a plate and angle girder. This is a built-up section composed of one main centre plate (made in two pieces) known as a web plate; this plate has 4

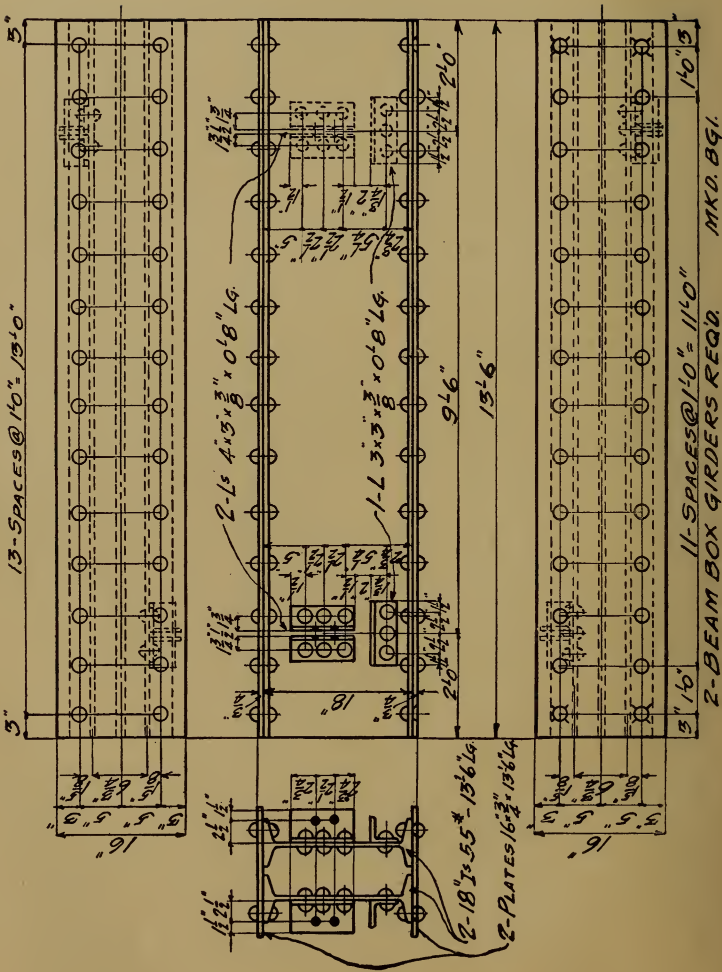
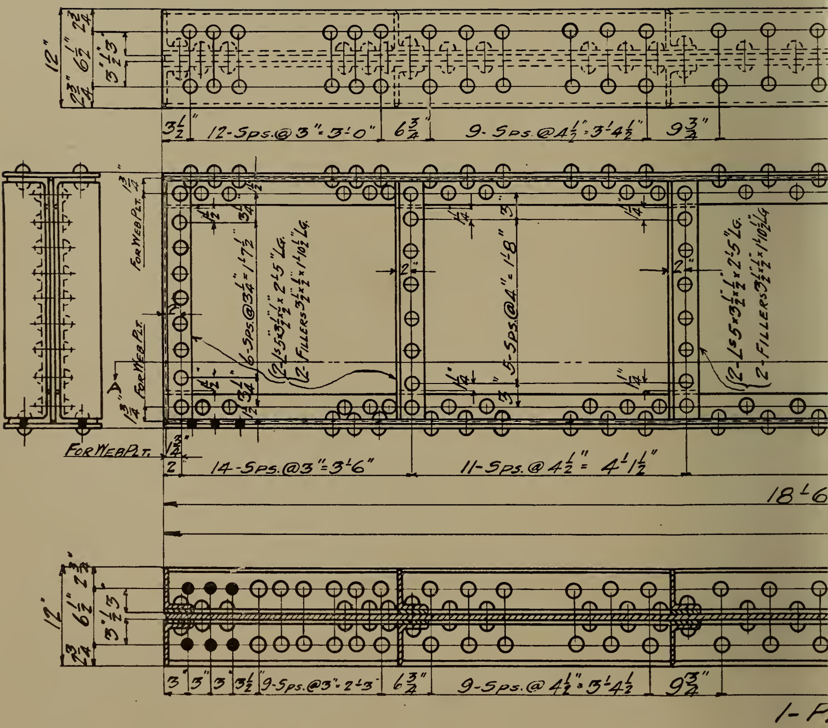

13-SPACES@1'-0"=13'-0"
11-SPACES@1'-0"=11'-0"
2-BEAM BOX GIRDERS REQ'D.
MKD. BG1.
2-Ls 4"x3"x3/8"x0'-8" LG.
1-L 3"x3"x3/8"x0'-8" LG.
9'-6"
13'-6"
2-18" Is 55# - 13'-6" LG.
2-PLATES 16"x3/4"x13'-6" LG.

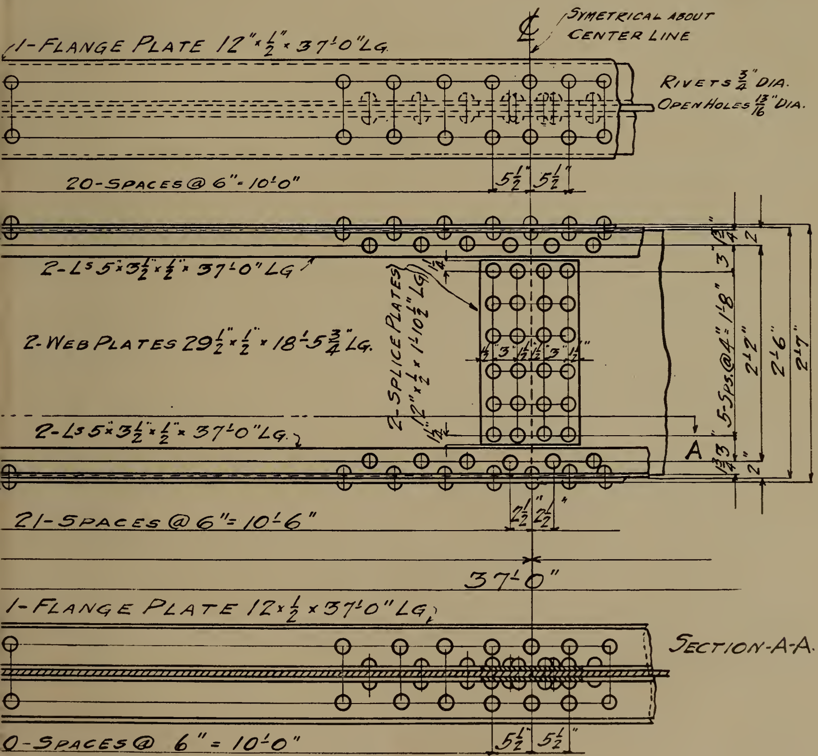
Fig. 32.

Fig



12-Sps.@3"=3'-0"
9-Sps.@4½"=3'-4½"
For Web Plt.
6-Sps.@3¼"=1'-7½"
2-Ls 5×3½×½"×2'-5"Lg.
2-Fillers 3½×½"×1'-10½"Lg.
5-Sps.@4"=1'-8"
14-Sps.@3"=3'-6"
11-Sps.@4½"=4'-1½"
18'-6
9-Sps.@3"=2'-3
9-Sps.@4½"=3'-4½
1-P

3.



TE GIRDER REQUIRED MARK G1.

main angles riveted to it, one at each side of the top and bottom, running horizontally; riveted to these angles, on the top and bottom of the girder, is a plate which is known as a flange plate; on the end of the girder and at various distances from the end are angles riveted to the web plate and top and bottom angles. These angles are known as stiffener angles; between these angles and the web plate are bars, of the same width as the legs of the angles, which are riveted to the web plate. These bars are known as filler bars and are generally called fillers.

At the right-hand end of the drawing it will be noticed that the girder has been broken off, and a centre line marked "℄" is shown slightly to the left; this centre line is marked "symmetrical about centre line." By this is meant that the girder is the same from centre line working toward the right as it is from the centre line working toward the left. This is a very convenient method of showing long objects which are identically the same from both sides of the centre line to the ends, as it not only saves the labor of drawing the whole object, but also saves space on the drawing.

All other views shown would be easily understood by the reader and require no comment, except that the view below the front view instead of being a bottom view is shown as a section. This section is taken as though the girder was cut on the line A A and the observer was looking down from above. This view is shown in this way so that full lines may be used to show distinctly the construction of the girder, instead of dotted lines which would of course be used if a regular bottom view were shown. Sometimes on a drawing this view is not marked "section," where it is so clearly shown to be a sectional view that to those who are in any degree familiar with drawings no mistakes will occur.

Fig. 34 represents what is known as a Z bar column. This is also a built-up section, composed of 4 Z bars riveted to a central plate known as a web plate. This is clearly shown by refering to the section marked A–A which also shows the construction of the base of the column. All the other views

are shown in such a manner that the reader should readily understand them.

Fig. 35 represents what is known as a Tee brace. The top view of the tee is shown identically as the top view of an I beam would be shown, and the front view is shown exactly as the front view of an angle would be shown. But we know it is neither an I beam nor an angle, for three reasons:

First, we must always study all the views of a drawing before we determine what the object represented looks like, for there are many objects that have one or more views which are identical, while the other views of these objects show in what particular respects they differ, and by doing this we easily see that it is not an I beam nor an angle.

Second, the name of the material itself is sufficient to distinguish it from any other section.

Third, the end view clearly shows the shape of the object to be a tee.

In this drawing there are several vital points that have not yet been explained. At the extreme right hand end of the tee, it will be noticed that there are dimension lines which form a triangle. On the horizontal dimension line is shown the dimension 12″ and the vertical dimension line is marked 9⅝″. This is called the level, and signifies that in order to bend this tee to the correct shape we must measure 12″ in a horizontal direction from the point at which the tee starts to bend, and on a line at right angles to this line (that is, a vertical line) we must measure 9⅝″, then, by drawing a line through this point to the point at which the angle starts to bend, we get the line or bevel or slope that the tee is to be bent.

Riveted to the other end of the tee is shown a plate on which some of the holes are also laid off on a bevel; this bevel is the same as the one already described, and, as the operation is clearly shown on the drawing, the student should not find any difficulty in following it.

The next point to which I wish to call the student's attention is that the drawing calls for two braces,—namely, one as

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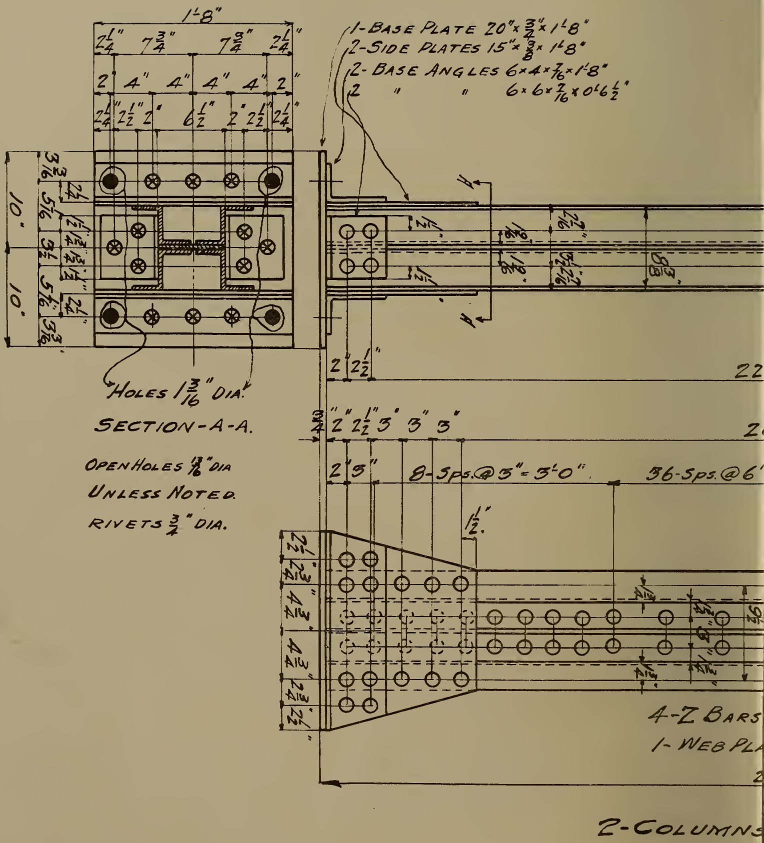
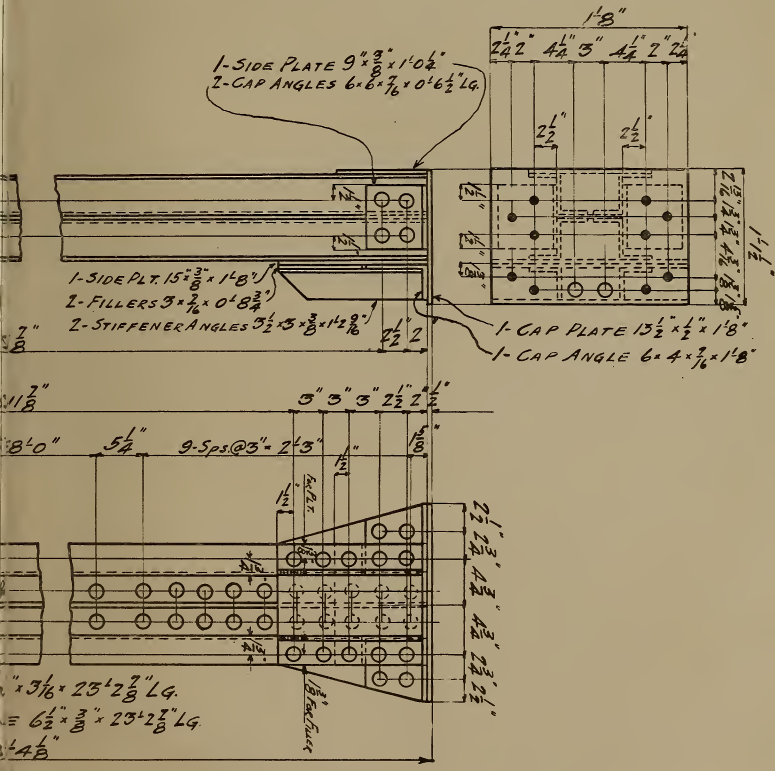


1-Base Plate 20"×3/4"×1'-8"
2-Side Plates 15"×3/8×1'-8"
2-Base Angles 6×4×7/16×1'-8"
2 " " 6×6×7/16×0'-6 1/2"
Holes 1 3/16" Dia.
Section-A-A.
Open Holes 13/16" Dia
Unless Noted.
Rivets 3/4" Dia.
8-Sps.@3"=3'-0"
36-Sps.@6'
4-Z Bars
1-Web Pl
2-Columns

4.


1'-8"
1-SIDE PLATE 9" x 3/8" x 1'-0 1/4"
2-CAP ANGLES 6 x 6 x 7/16 x 0'-6 1/2" LG.
1-SIDE PLT. 15" x 3/8" x 1'-8"
2-FILLERS 3 x 3/16 x 0'-8 3/4"
2-STIFFENER ANGLES 3 1/2 x 3 x 3/8 x 1'-2 9/16"
1-CAP PLATE 13 1/2" x 1/2" x 1'-8"
1-CAP ANGLE 6 x 4 x 9/16 x 1'-8"
9-Sps.@3" = 2'-3"
5 1/4"
8'-0"
x 3/16 x 23'-2 7/8" LG.
= 6 1/2" x 3/8" x 23'-2 7/8" LG.
For Plt.
For Filler

REQ'D. MARK 1.

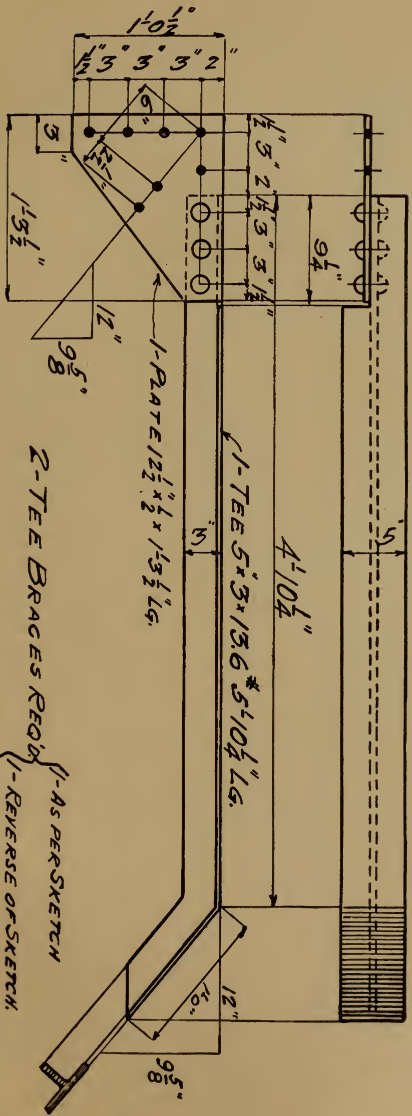

1-PLATE 12½"×½"×1'-3½" LG.
1-TEE 5"×3"×13.6# 5'-10¼" LG.
2-TEE BRACES REQ'D. 1-AS PER SKETCH
1-REVERSE OF SKETCH.

Fig. 35.

per sketch and one the reverse of the sketch. This is sometimes written, "1 Req'd, Right Hand, 1 Req'd, Left Hand, or 1 as per Sketch, 1 Opposite Hand." All these terms mean the same,—that is, that one piece is to be made exactly as it is shown in the drawing, and the other piece is to be made of the same size but just the reverse in shape.

In order that the reader may clearly understand this method of showing right-handed and left-handed views of objects, the opposite hand or reverse of the object seen in Fig. 35 is shown in Fig. 36. The student will notice that Fig. 35 is not simply turned around in Fig. 36, for if that were the case the plate on the end of the tee would be shown on the far side of the tee instead of on the near side, and there would be no necesssity for making these braces right- and left-hand.

Now, the easiest way to find out what the reverse or opposite hand of an object looks like is to make, on a piece of paper that you can see through when you hold it before a bright light, a sketch of the object exactly as it is shown on the drawing, then by holding this paper before the light with the sketch side toward the light, you will see the reverse or the opposite hand of the object. However, if the paper or blue print on which the object was originally drawn is transparent, it is not necessary to redraw it; simply hold it to the light in the manner described above. Try this, so you may see exactly how it works, before leaving this chapter.

On the top view at the right-hand end of Fig. 35 and the left-hand end of Fig. 36, where the tee starts to bend, will be noticed a series of lines the same distance apart and as long as the width of the flange of the tee. These lines are very light where the tee starts to bend, but gradually increase in thickness as they near the end of the tee. These lines are called shade lines which represent a flat surface and show that the tee is bent. As, however, the front view shows that the tee is bent and how it is bent, they are not absolutely necessary, but are placed on some drawings to show that an object is bent, when there is danger that the other views might not be taken into consideration in a hurried glance. Another rea-

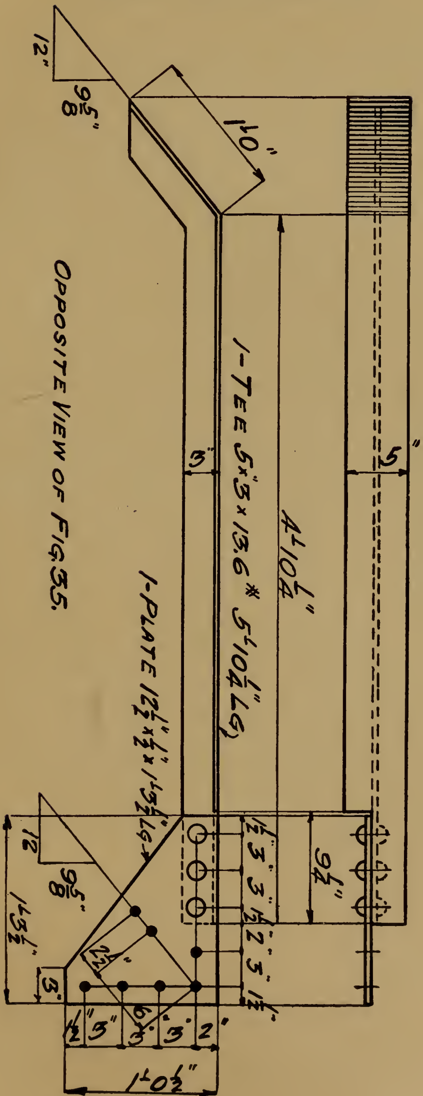
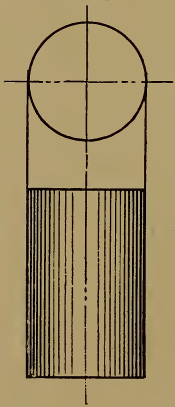

OPPOSITE VIEW OF FIG. 35.
1-TEE 5"x3"x13.6# 5'-10¼" LG.
1-PLATE 12½"x½"x1'-3½" LG.
4'-10¼"
1'-0"
1'-0½"
1'-3½"
9¼"
9⅝"
12"

Fig. 36.

son why they are not used, when a drawing is otherwise well made, is that they might interfere with the clearness of a practical drawing.

Fig. 37 shows the method of presenting the shade lines of a curved surface or clyinder. The lines are light near the centre of the cylinder, with large spaces between them, but as they near either side the spaces gradually decrease in width and the lines become heavier.

Fig. 37.



However, when there are other views shown which indicate the object as having a curved surface, it is not necessary to show by shade lines that the surface is curved, for, as explained before, these shade lines might interfere with the clearness of the drawing.

The reader should by this time be able to understand any structural drawing, and in fact any drawing if he is familiar with the material which is represented by it, for with all classes of projection drawing objects are shown by the same principles. There are, however, several points in what is known as Mechanical and Architectural Drawing that have as yet not been explained. The most important of these points will be taken up in the following chapters; but let the reader clearly understand that, while these various points may apply only to mechanical or architectural drawing, his knowledge of drawings is not complete without them, and failure on his part to become familiar with them will only result in his own loss.

CHAPTER VIII

Mechanical Drawings

As mechanical drawings deal to a great extent with curved surfaces, our first consideration in this chapter will be the circle, as every curve is a portion of some circle.

A circle is a single curved line every part of which is an equal distance from a point called the centre.

Fig. 38.

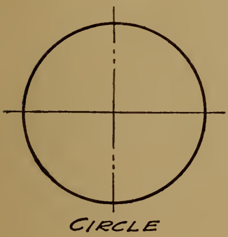
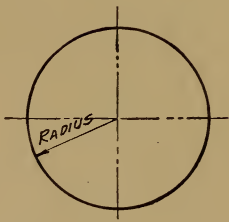


Fig. 39.

Fig. 40.



The distance around a circle is called the circumference of the circle.

The distance across a circle, through the centre, is called the diameter.

The radius of a circle is the distance from the centre of the

Fig. 41.

Fig. 42.

circle to its circumference, or one-half the diameter of a circle equals the radius.

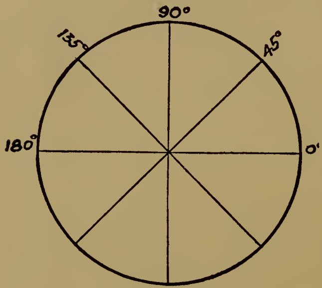
Any portion of the circumference of a circle is called an arc.

The chord of a circle is a straight line joining the extremities of an arc but which does not pass through the centre of

the circle; if it passed through the centre of the circle, it would be called the diameter.

For convenience in measuring any portion of a circle, the circumference is divided into 360 equal parts called degrees. Therefore, if a circle is divided into two equal parts, or in halves, each part contains 180 degrees. If we divide the circle into four equal parts, or in quarters, each part contains 90 degrees. If we divided it into eight equal parts, or in eighths, each part would contain 45 degrees, etc.

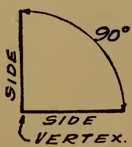
FIG. 43.



In order to obtain very accurate dimensions, each degree is divided into 60 equal parts called minutes, and each minute is again divided into 60 equal parts called seconds. Instead of using words to express degrees, minutes, and seconds, the following symbols are used:

The symbol ° means degree or degrees
The symbol ′ means minute or minutes
The symbol ″ means second or seconds

FIG. 44.



RIGHT ANGLE

FIG. 45.

ACUTE ANGLE

FIG. 46.

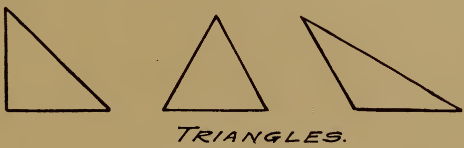
OBTUSE ANGLE

Thus, if we wished to express fifty-six degrees, one minute and twenty-two seconds, it would be written 56° 1′ 22″. These symbols are written above the line that the figures are on, and are so much smaller that they will not be mistaken for figures.

An angle is formed when two straight lines meet. The lines are called the sides of the angle and the point where the lines meet is called the vertex of the angle. An angle which contains 90° is called a right angle. See Fig. 44.

When an angle contains less than 90° it is called an acute angle. See Fig. 45.

FIG. 47.

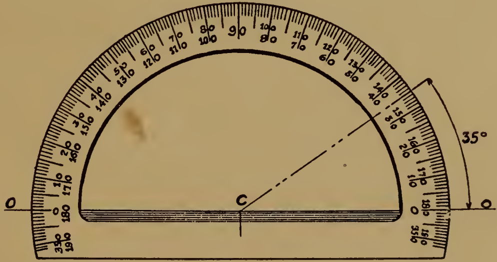


An angle of more than 90° is called an obtuse angle. See Fig. 46.

A triangle is formed by connecting the extremities of the sides of an angle with another straight line. See Fig. 47.

A protractor is an instrument used for measuring degrees and proportions of degrees. See Fig. 48.

FIG. 48.



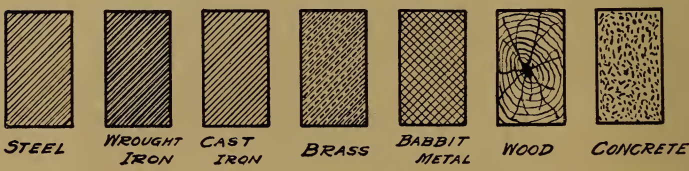
For convenience, protractors are numbered from 0° to 180° in both directions, so that the number of degrees or portions of degrees may be easily found by starting from either the right-hand or left-hand side of the diameter of any circle. In using a protractor it must be placed so that the line forming one side of the angle will be in line with the points 0–0 on the protractor and the vertex of the angle must be at the point marked C. Thus, to lay off 35 degrees (see Fig. 48),

start at the line marked o at the right-hand side of the protractor, then from the point where the divisions show 35 degrees draw a line to the vertex, marked C; this will give you an angle of 35 degrees.

On a drawing the different kinds of material used in the construction of an object may be indicated in the sections by various methods of shading. Some of these methods are shown in Fig. 49, and they have been universally adopted by the leading engineers of this country as standard. However, each kind of material presented on a drawing should be clearly marked with the name of the material out of which it is made.

Steel is indicated by drawing two light lines close together, then leaving a space equal to the two light lines, then repeating with two more light lines, etc.

FIG. 49.



Wrought iron is indicated by alternate light lines and heavy lines at equal distances apart.

Cast iron is represented by a series of parallel light lines an equal distance apart.

Brass is indicated by alternate light full lines and light dotted lines.

Babbit metal is indicated by light lines which cross each other.

Wood is sectioned by a series of irregular curved and radiating lines, and resembles the cross section of a tree.

Concrete is indicated by dots and small dashes.

There are many other materials for which standard methods of sectioning have been adopted, but, as a general rule, when a material is indicated on a drawing, the name of that material is noted somewhere on the drawing.

CHAPTER IX

Gearing; Finishing; Storage Tank; and Valve

Fig. 50 represents what is known as a gear wheel. In this drawing is shown the method of projecting from one view to another; this method has been explained in detail in previous chapters.

There are several terms used in connection with gearing that the student should become familiar with; these terms or names, it will be noticed, are marked on the drawing, the meaning of which should be self evident.

A complete treatise on gearing may be secured at very little expense by applying to any well-known manufacturers of gear-cutting machinery, who issue catalogues and booklets on this subject. The Brown & Sharp Manufacturing Company, of Providence, Rhode Island, publish a book called "A Practical Treatise on Gearing," which is, in my estimation, one of the best books on this subject that is published.

There is a point in connection with drawings which has not been explained before and to which I wish to call the reader's attention, and that is in reference to the finishing of material, or the machine work. When it is necessary to perform any finishing work on material, such as boring, turning, drilling, planing, threading, etc., or doing any work by the use of machinery, the operations performed are generally known as machine work. Before any machine work has been performed on a casting, the casting is known to be in the rough. When it is required to perform machine work on a certain portion of the casting, such as facing the ends of the hub of a gear wheel (see Fig. 50), the casting in the rough is made a trifle larger at this point than the dimensions called for on the drawing, so that before this casting is machined there shall be a little surplus material on the casting which is cut off by the machine. By this method, the casting can be finished to a true, smooth surface, the machinist adhering to the dimensions shown on

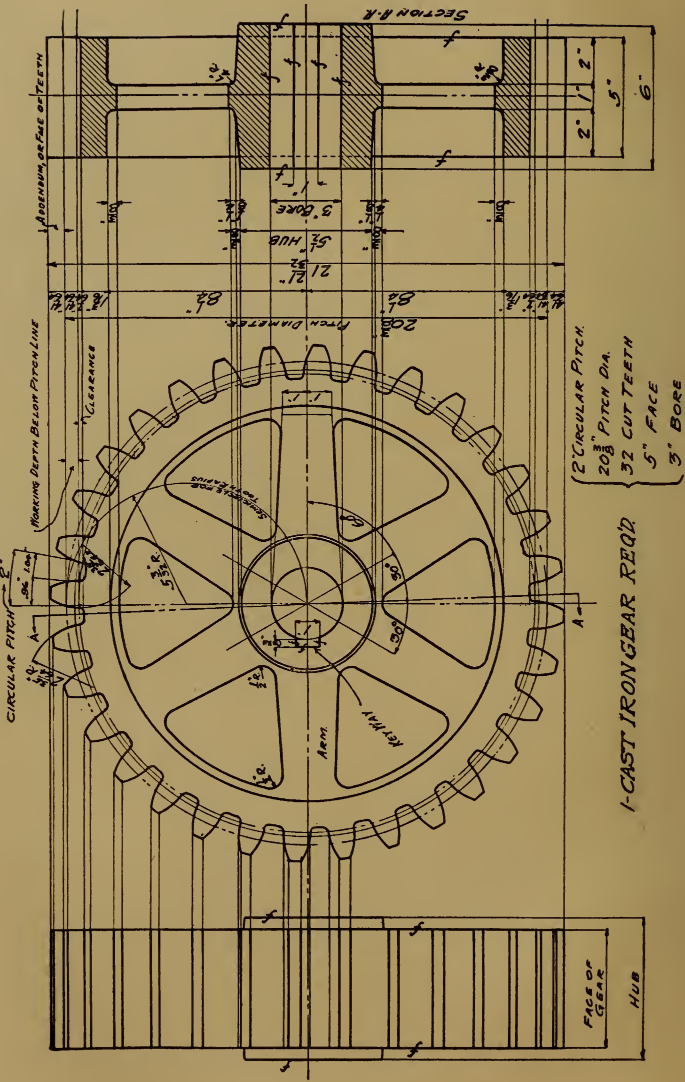

SECTION A-A
3" BORE
5½" HUB
21 21/32"
PITCH DIAMETER
20⅜"
ADDENDUM, OR FACE OF TEETH
WORKING DEPTH BELOW PITCH LINE
CLEARANCE
CIRCULAR PITCH
SEMICIRCLE FOR TOOTH RADIUS
ARM
KEYWAY
2" CIRCULAR PITCH
20⅜" PITCH DIA.
32 CUT TEETH
5" FACE
3" BORE
1-CAST IRON GEAR REQ'D
FACE OF GEAR
HUB

FIG. 50.

the drawing. This surplus material is usually called stock or finish.

When an object is to be machined or finished, any of the following words are used to denote the machine work: bored, planed, milled, faced, etc. There is another mark or symbol, however, that is a substitute for any of these words,—that is, the letter "f," which denotes, wherever it occurs on a drawing, that that part of the material is to be finished or machined.

Cored holes, or cored openings, are made in the process of moulding castings; they are considered rough holes, and are usually made from ⅛″ to ¼″ larger than the bolts, etc., which fit into them. Cored holes are generally used when it is not necessary to make a water-tight joint, and where it is practical to core the holes in the process of moulding.

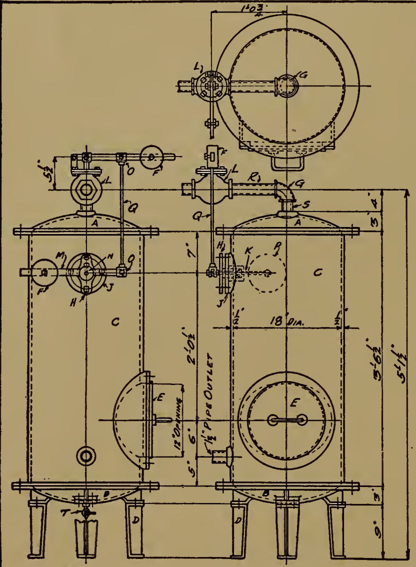
Fig. 51 represents what is known as a cast-iron storage and settling tank. This tank is used for the double purpose of storing a liquid and at the same time allowing any sediment which may be in it to settle to the bottom of the tank.

The construction of the tank is very simple, and, by applying the principles described in the previous chapters, should be readily understood; but, as this subject affords an excellent opportunity to review some of the minor points which we have passed over in the last chapter or so, we will go into it in detail. The tank in its erected form is shown by Fig. 51, which also includes a bill of material. This bill of material is simply a list of all the material required to build the tank, and the details of all the parts, that are not of a standard make, are clearly shown by Fig. 52.

Fig. 51 shows the tank to have four legs, marked "D," at the bottom of the tank. These four legs are connected to the bottom head, marked "B." In each of these legs are two cored holes for ⅝″ diameter machine bolts, which are shown in the bill of material as being 1⅞″ long. As these bolts are of standard make and can be ordered or secured from any dealer who handles this class of material, no detail drawing is shown or required, as is the case with all the bolts which are required

for the construction of this tank. As will be noticed by referring to the detail shown by Fig. 52, the top of these legs and the bottom of the lugs, which are on the bottom head and onto which the legs are to be connected, have finished surfaces, as is designated by the symbol "f." These surfaces are machined or finished so that the heater will rest squarely upon

FIG. 51.

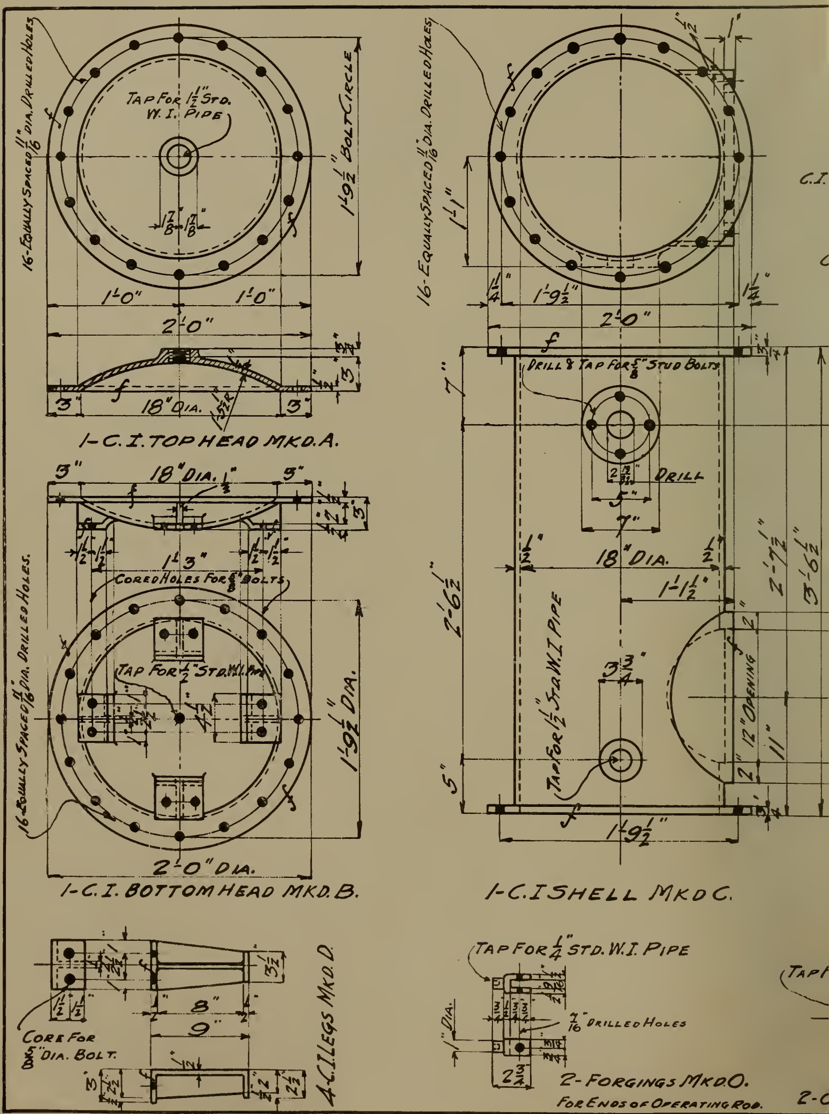


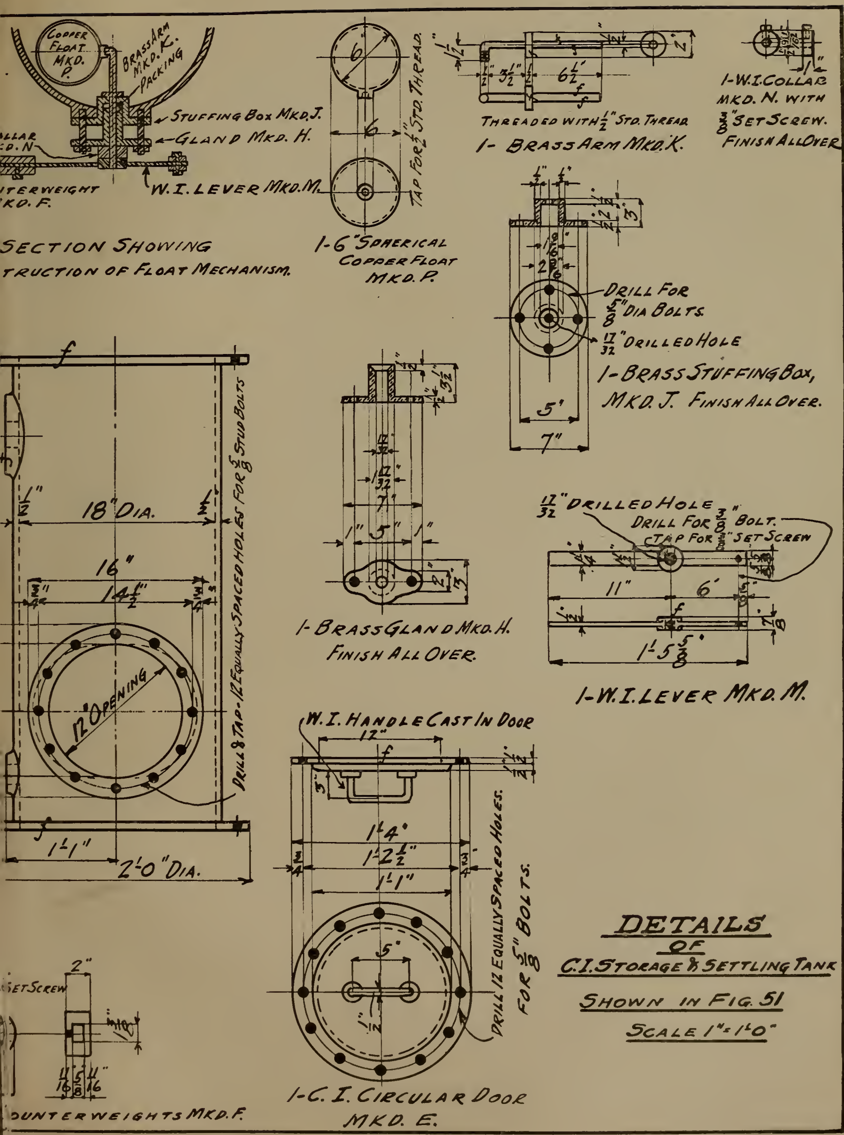
BILL OF MATERIAL.		
MARK	No. of Pieces	DESCRIPTION
A	1	C.I. Top Head
B	1	" Bottom Head
C	1	" Shell 18" I.S. Dia. × 9'6½" Lg.
D	4	" Legs
E	1	" Circular Cleaning Door & Handle
F	2	" Counterweights
G	1	" Standard Elbow For 1½" Dia. Pipe
H	1	Brass Gland
J	1	" Stuffing Box
K	1	" Arm For Float
L	1	Standard 1½" Balance Valve
M	1	W.I. Lever
N	1	" Collar For Brass Arm.
O	2	Forgings For Operating Rod
P	1	6" Copper Float
Q	1	Piece ½" W.I. Pipe For Operating Rod
R	1	" 1½" " " For Inlet 8¼" Lg.
S	1	" 1½" " " Nipple 2¾" Lg.
T	1	Standard ½" Brass Stop Cock
	32	Machine Bolts ⅝" Dia × 2⅜" Lg For Heads
	16	" " ⅝" " " 1⅞" " " Legs
	2	" " ⅜" " " 2¼" " " Forgings
	12	Stud Bolts ⅝" " " 2⅛" " " Door
	2	" " ⅝" " " 4¼" " " Gland
	2	" " ⅝" " " 1⅞" " " Stuffing Box
	2	Set Screws ⅜" " " ¾" " " Counterweights
	1	" " ⅜" " " ⅝" " " Collar

1-C.I. STORAGE & SETTLING TANK
SCALE-1"-1'-0"

its legs. The holes in the lugs of the bottom head and in the top of the legs are cored, because in this case it is not necessary that this joint should be water-tight and it is usually cheaper to core holes than to drill them. In the centre of the bottom head will be noticed a hole which is to be tapped for standard W. I. pipe. Into this hole is screwed a standard ½" brass stopcock, marked "T," which like the bolts may be purchased from any dealer who handles this class of material,

F


16-EQUALLY SPACED 11/16" DIA. DRILLED HOLES
TAP FOR 1 1/2" STD. W.I. PIPE
1'-9 1/2" BOLT CIRCLE
1'-0"
1'-0"
2'-0"
18" DIA.
1-C.I. TOP HEAD MKD. A.
CORED HOLES FOR 5/8" BOLTS
TAP FOR 1/2" STD. W.I. PIPE
16-EQUALLY SPACED 11/16" DIA. DRILLED HOLES.
1'-9 1/2" DIA.
2'-0" DIA.
1-C.I. BOTTOM HEAD MKD. B.
CORE FOR 5/8" DIA. BOLT.
4-C.I. LEGS MKD. D
16-EQUALLY SPACED 11/16" DIA. DRILLED HOLES
1'-9 1/2"
2'-0"
DRILL & TAP FOR 5/8" STUD BOLTS
DRILL
18" DIA.
TAP FOR 1 1/2" STD. W.I. PIPE
12" OPENING
2'-6 1/2"
2'-7 1/2"
3'-6 1/2"
1-C.I. SHELL MKD C.
TAP FOR 1/4" STD. W.I. PIPE
7/16" DRILLED HOLES
1" DIA.
2-FORGINGS MKD O.
FOR ENDS OF OPERATING ROD.
C.I.


SECTION SHOWING
TRUCTION OF FLOAT MECHANISM.
COPPER FLOAT MKD. P.
BRASS ARM MKD. K.
PACKING
STUFFING BOX MKD. J.
GLAND MKD. H.
W.I. LEVER MKD. M.
1-6" SPHERICAL COPPER FLOAT MKD. P.
TAP FOR 1/2" STD. THREAD
THREADED WITH 1/2" STD. THREAD
1- BRASS ARM MKD. K.
1-W.I. COLLAR MKD. N. WITH 3/8" SET SCREW. FINISH ALL OVER
DRILL FOR 5/8" DIA BOLTS
17/32" DRILLED HOLE
1-BRASS STUFFING BOX, MKD. J. FINISH ALL OVER.
18" DIA.
16"
14 1/2"
12" OPENING
DRILL & TAP-12 EQUALLY SPACED HOLES FOR 5/8 STUD BOLTS
2'-0" DIA.
1-BRASS GLAND MKD. H. FINISH ALL OVER.
17/32" DRILLED HOLE
DRILL FOR 3/8" BOLT.
TAP FOR 3/8" SET SCREW
1'-5 5/8"
1-W.I. LEVER MKD. M.
W.I. HANDLE CAST IN DOOR
DRILL 12 EQUALLY SPACED HOLES. FOR 5/8" BOLTS.
1-C.I. CIRCULAR DOOR MKD. E.
SET SCREW
OUNTERWEIGHTS MKD. F.
DETAILS OF C.I. STORAGE & SETTLING TANK SHOWN IN FIG. 51
SCALE 1"=1'-0"

and therefore requires no detail drawing. The purpose of this stopcock is to drain the tank when the occasion requires it.

Connected to the bottom head "B" is a cylindrical shell marked "C." This shell is 18″ inside diameter and 3′ 6½″ in length. At the top and bottom of the shell are flanges which are 2′ 0″ outside diameter. These flanges have finished surfaces and edges, and 16 holes are drilled in each flange for bolts ⅝″ diameter. When this tank is being erected, between these flanges and the flanges of the top and bottom heads are placed white lead and what is known as cotton torch-wick; this is done to make sure that the joints shall be water-tight. Near the bottom of this shell is shown a 12″ opening, which is covered by a circular cleaning door, marked "E." This cleaning door is held in place by 12 stud bolts (which are bolts which have no heads, both ends being threaded, and these bolts are screwed into tapped holes which are provided for them); the face of this opening and the flange of the door are machined, and white lead and cotton wick are used to make this joint water-tight. There are two other openings in this shell,—one, near the bottom, for a 1½″ pipe outlet, through which the liquid flows from the tank, and the other, on the same side of the shell near the top, through which the arm that operates the float passes.

This particular point may be more thoroughly understood by studying the section at the top of Fig. 52. In the inside of this tank after it is erected is a copper float, marked "P," which on account of its buoyancy always floats on the liquid in the tank, and this float, by moving up or down as the tank either fills or empties, operates (shuts off or opens) the balance valve, marked "L," which is shown at the top of the tank on Fig. 51. This balance valve is connected to a wrought-iron lever, marked "M," by an operating rod "Q," to which at each end is attached a forging, "O." This wrought-iron lever, "M," is attached to a brass arm, marked "K," and on the end of the arm "K" is connected the copper float "P." In order that this arm "K" may pass through the side of the tank without causing the tank to leak, a stuffing-

box, marked "J," and a gland, marked "H," are used. The stuffing-box fits into the opening in the side of the shell and is held in place by a stud bolt at the right and left side of the stuffing-box. Into the stuffing-box the gland "H" fits, and this gland is held in place by a stud bolt at the top and bottom of the gland. These stud bolts are longer than the stud bolts which hold the stuffing-box in place, and they are tapped into the shell and go through the stuffing-box and gland. This construction allows the gland to move in and out, as the nuts of the stud bolts are tightened or loosened. This is done for the reason that at the end of the gland, between the gland and the stuffing-box, packing is placed, and, as this packing wears out, the nuts on these stud bolts may be tightened and will press the packing closer to the brass arm "K," or they may be loosened and the gland removed and new packing put into place.

The balance of these details should be readily understood, as all that remains to be explained is, that at the top of the heater the top head is tapped to receive a 1½" inlet nipple; this is screwed into a standard C. I. elbow, which in turn is connected to a 1½" W. I. pipe that leads to a standard balance valve. All these pipe fittings being standard, no detail drawing is required. On the lever of the balance valve "L," and the W. I. lever "M," are placed counterweights, "F," which are used simply to adjust the operation of the valve.

As all the parts of this tank that are not standard are detailed, the student should carefully go over each detail and see exactly where each part fits in the construction of this tank, as there may be very many important things that are not quite clear at the first glance, and in this subject the student will find many points in mechanical drawing that he will meet with in the course of his career. Therefore, again I say, do not pass this chapter without clearly understanding all that it contains, for to miss any of the small particulars set forth here might be a stumbling-block at some future time. Think this all out for yourself, and any other points that you may come across, and, if you do not fully understand it all, go over it

again; if necessary, start at the beginning of the book; it is all explained, and has been fully understood by others and can be by you if you have a little patience and do not hurry through it or give it a careless glance, and, if you succeed, and understand it all, you may be positively sure that you can master any well-made drawing that you will come in contact with.

Fig. 52 A represents what is known as a 6″ globe valve. This style of valve is generally used on steam lines, and, as it is so completely shown, no detailed explanation is necessary. The student, however, should not pass hurriedly over this drawing, but should study out, and thoroughly understand, all that it contains.

In reference to the next chapter, entitled Architectural Drawing, do not be misled by the name, for, while you may think that you will have no need for the information contained therein, go through it to the end and your views will change; and after you have mastered it, as you have mastered these other branches, you would not part with your information at any price.

CHAPTER X

Architectural Drawing

In this treatise it is my intention simply to show the reader the general manner in which structures, buildings, etc., are represented by projection drawing. Usually there accompany every set of drawings of a building or structure what are known as specifications. These specifications are written descriptions of the structure; they also specify the name and quality of all the materials which are to be used throughout the structure, and they are intended to supply any information which could not be conveniently given on the drawing.

The first illustration in this chapter, Fig. 53, represents the shape and size of a plot of ground and the plan view of the foundation of an ordinary dwelling-house. This plan is shown as though it was a section taken immediately below the first-floor line or directly above the level of the ground. In this view it can readily be seen how the house will be situated on the plot of ground, or lot, as the size and shape of the foundation walls and various other dimensions are given.

Fig. 54 represents the plan view of the first-floor, and is shown as though it was a section taken immediately above the first-floor line. In this view are indicated the size of the various rooms and hall, location of windows, doors, and chimneys, and the thickness of walls, width of stairs, and other important dimensions are given.

Fig. 55 is a plan view of the second floor, which is shown as though it were a section taken immediately above the second-floor line. This view, like the plan view of the first floor, shows the shape and location of the rooms, halls, walls, stairs, etc., as well as the most important dimensions.

Fig. 56 shows the plan of the attic or third floor. This view is taken as though it were a section immediately above the third-floor line, and, like the first- and second-floor plans, all the necessary dimensions are given.

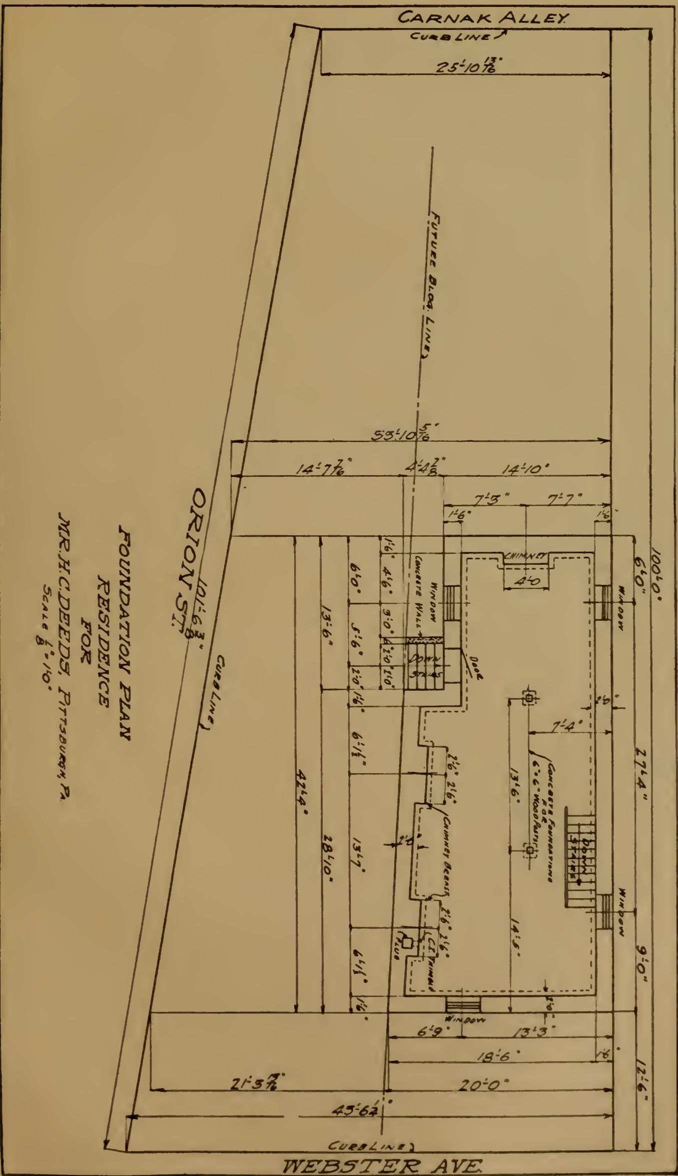

CARNAK ALLEY
CURB LINE
25'-10 13/16"
FUTURE BLDG. LINE
53'-10 5/16"
14'-7 7/16"
4'-4 7/8"
14'-10"
7'-3"
7'-7"
ORION ST.
101'-6 3/8"
CURB LINE
FOUNDATION PLAN
RESIDENCE
FOR
MR. H. C. DEEDS, PITTSBURGH, PA.
CHIMNEY
WINDOW
CONCRETE WALL
DOWN STAIRS
DOOR
CHIMNEY BREAST
WINDOW
100'-0"
27'-4"
9'-0"
12'-6"
6'-9"
13'-3"
18'-6"
21'-3 7/16"
20'-0"
45'-6 1/4"
CURB LINE
WEBSTER AVE.

FIG. 53.

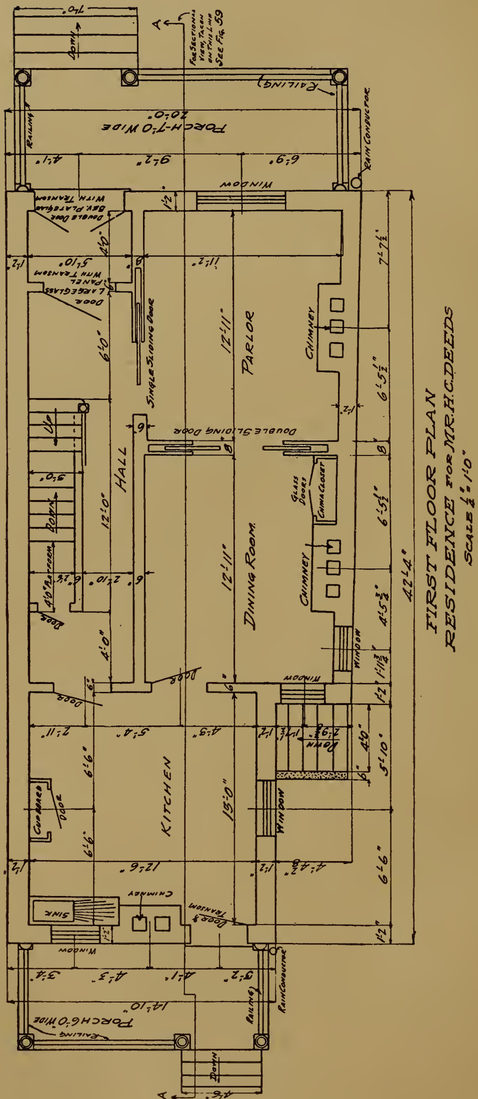

FIRST FLOOR PLAN
RESIDENCE FOR MR. H. C. DEEDS
SCALE 1/4" = 1'0"
PARLOR
DINING ROOM
KITCHEN
HALL
PORCH - 7'-0" WIDE
PORCH 6'-0" WIDE
RAILING
RAIN CONDUCTOR
WINDOW
CHIMNEY
DOUBLE SLIDING DOOR
SINGLE SLIDING DOOR
CHINA CLOSET
GLASS DOORS
CUPBOARD
SINK
DOWN
UP
FOR SECTIONAL VIEW, TAKEN ON THIS LINE SEE FIG. 59
42'-4"

FIG. 54.

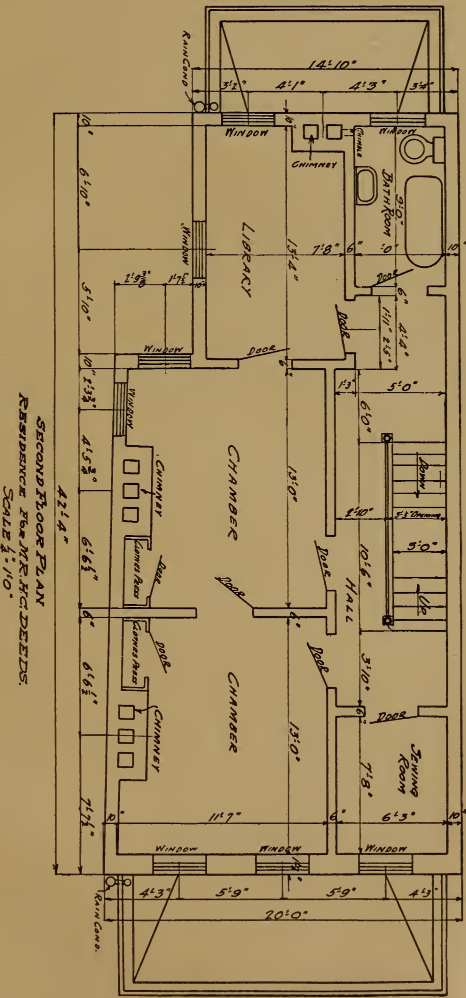
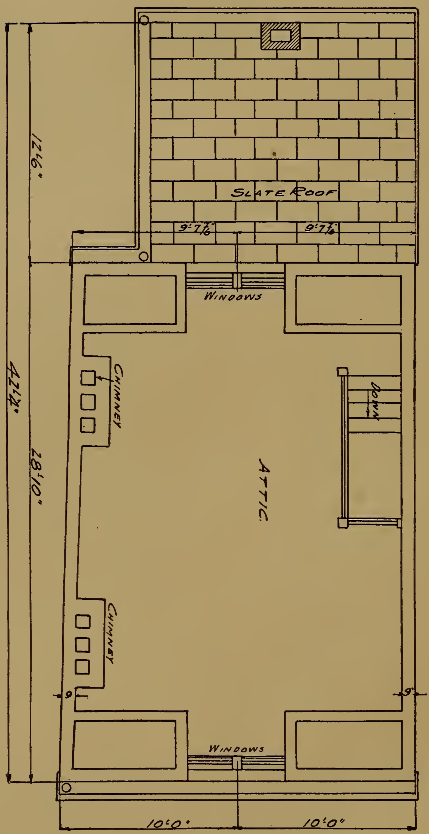

SECOND FLOOR PLAN
RESIDENCE FOR MR. H.C. DEEDS.
SCALE ¼":1'0"
LIBRARY
CHAMBER
CHAMBER
HALL
BATH ROOM
SEWING ROOM
CHIMNEY
CHIMNEY
CHIMNEY
CLOTHES PRESS
CLOTHES PRESS
WINDOW
DOOR
DOWN
UP
RAIN COND.
RAIN COND.
14'10"
20'0"
42'4"

FIG. 55.

FIG. 56.



THIRD FLOOR PLAN
RESIDENCE FOR MR. H. C. DEEDS.
SCALE ¼" = 1'-0"

Fig. 57 represents the front view, or front elevation, of the house, showing the style of porch, steps, doors, windows, roof, and the various ornamentations of the front of the house.

Fig. 58 presents the rear view, or rear elevation, of the house, and, as in the front view, or front elevation, all the prominent parts, such as porch, doors, windows, chimneys, rain conductors, roof, etc., are shown.

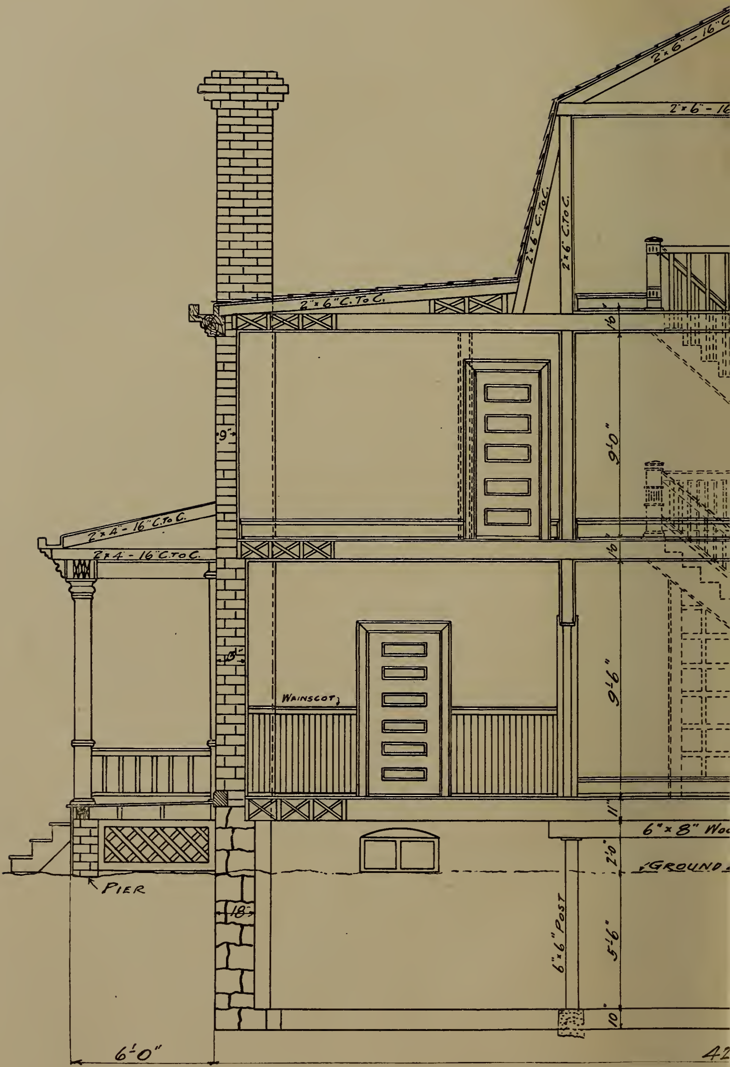
Fig. 59 represents a longitudinal section of the house,—that is, a section taken through the lines A–A on the first-floor plan. In this view is shown all the visible interior of the house as it would look if the house were to be cut along the line A–A and the part nearest to you were removed. All the important dimensions which were not given in the other views are given in this view, such as the depth of the foundation, height of stories, size of joists, etc.

By studying these drawings the reader should be able thoroughly to understand the general requirements of the building. In ordinary buildings of this kind it is very seldom necessary to give any details other than those that are shown for windows, doors, fireplaces, porch columns, etc., as the specifications generally state the quality of the material which is to be used, and the manufacturers of this material issue illustrated catalogues, or have show-rooms in which can be seen the various styles of doors, windows, fireplaces, chandeliers, stairways, etc., from which the architect, contractor, or owner generally selects the designs of these objects according to his own taste. However, if it is desired to have some particular object, such as a china-closet, etc., that is not standard, the architect generally shows a detail of it, which when given may be readily understood in accordance with the principles set forth in the preceding chapters.

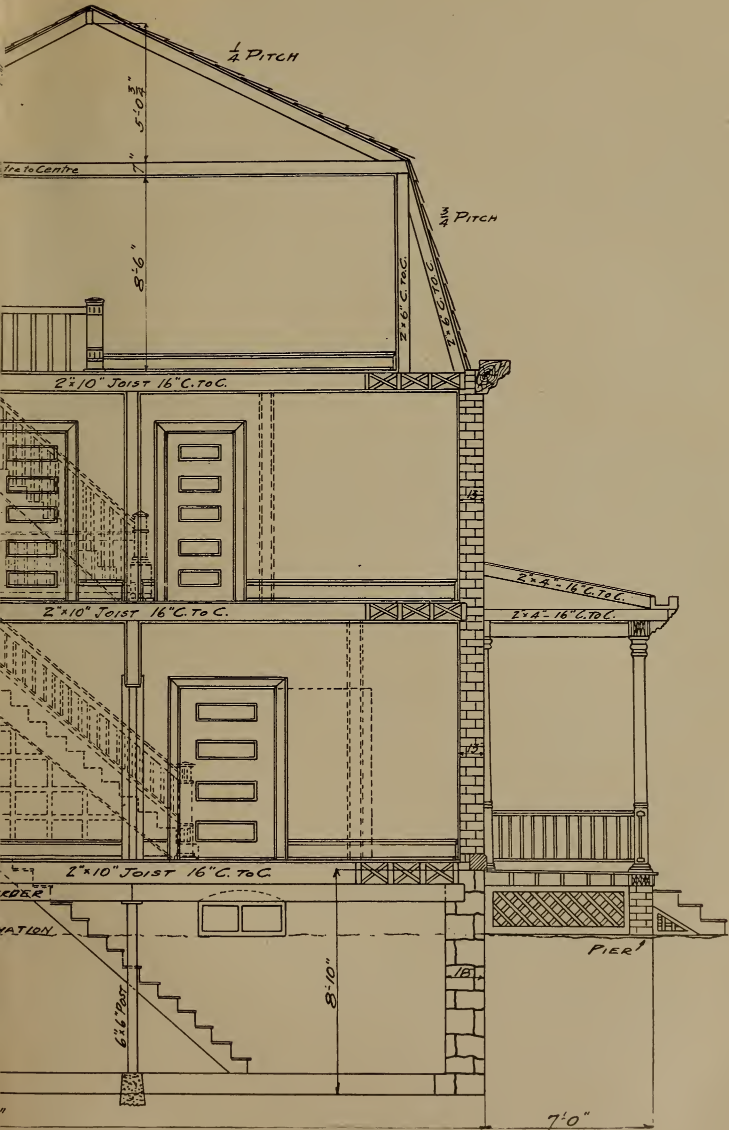
In designing large buildings, especially where steel construction is used, the architect provides what is known as framing plans, which give the size and general dimensions of the structural material used in the construction of the building. These framing plans are simply the plan views showing the material which is used, at a point immediately below the floor line.

FIG. 57.

Front view or front elevation, residence for Mr. H. Deeds.

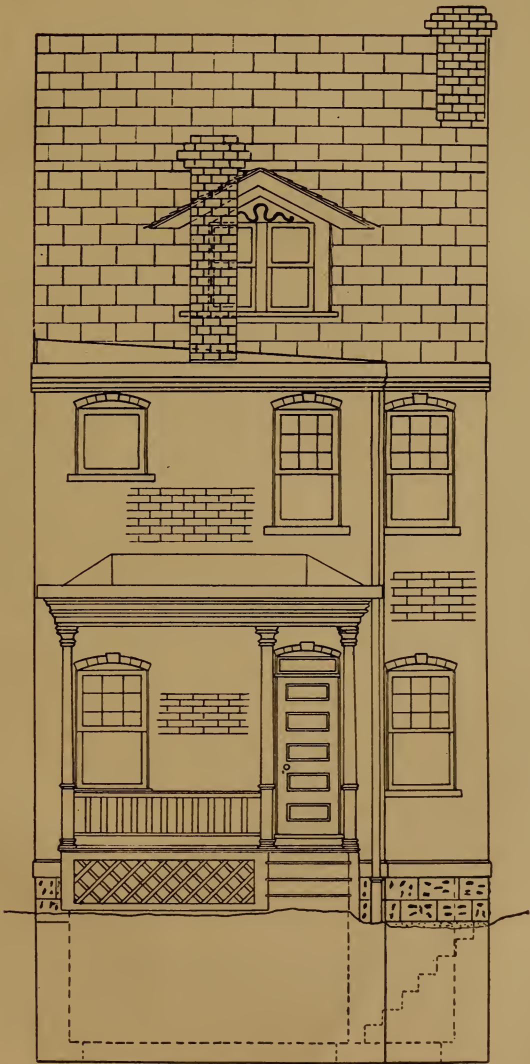


Longitudinal Section of



idence for Mr. H. Deeds.

FIG. 58.



Rear view or rear elevation, residence for Mr. H. Deeds.

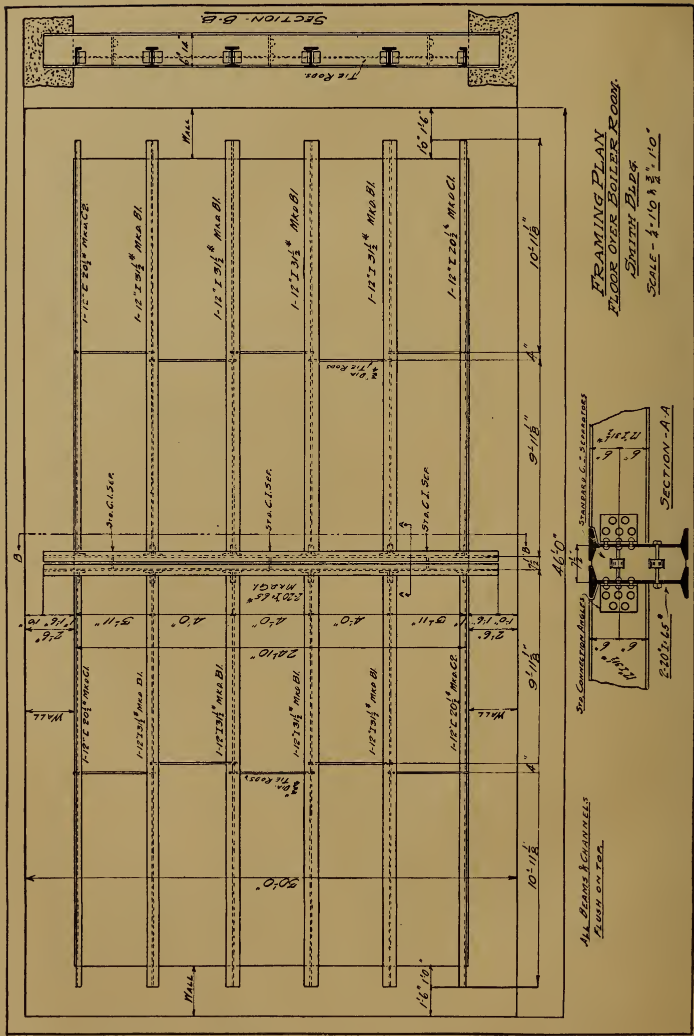

FRAMING PLAN
FLOOR OVER BOILER ROOM.
SMITH BLDG.
SECTION - B-B
SECTION - A-A
TIE RODS
STD. C. I. SEP.
WALL
46'-0"
30'-0"
24'-10"
ALL BEAMS & CHANNELS
FLUSH ON TOP.

Fig. 60.

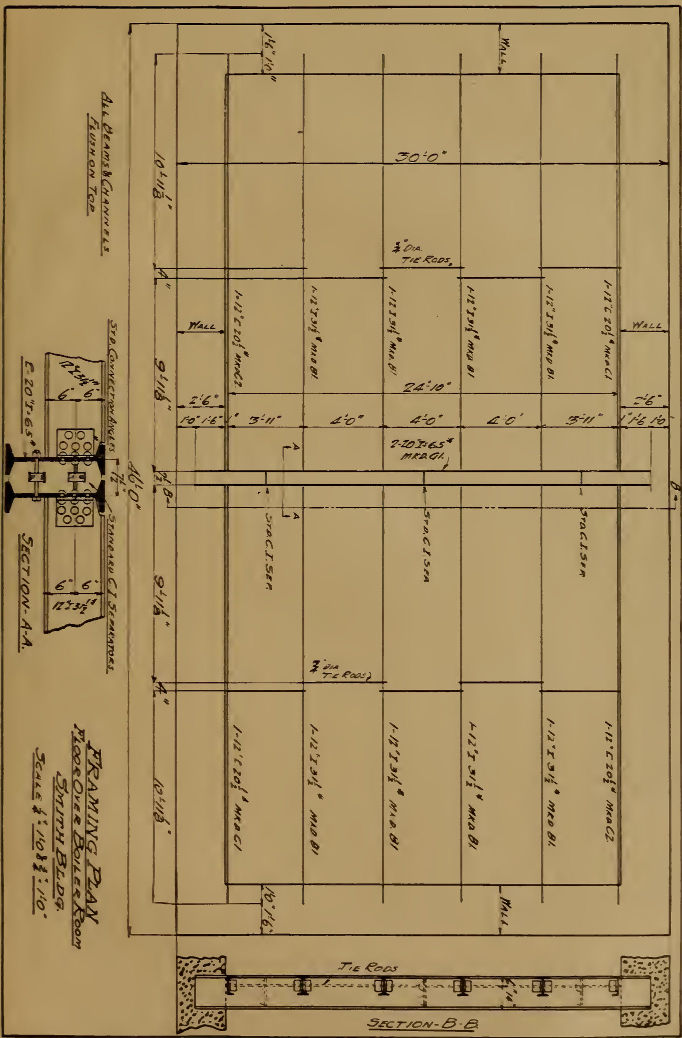

FRAMING PLAN
FLOOR OVER BOILER ROOM
SMITH BLDG.
ALL BEAMS & CHANNELS FLUSH ON TOP
SECTION-A-A
SECTION-B-B
TIE RODS
30'-0"
24'-10"
46'-0"
WALL

FIG. 61.

Fig. 60 represents the plan view of the structural framing of the building immediately below the floor line, and the sections show how the different members are connected together. The reader should have no trouble in following this drawing, for with the addition of a few intermediate dimensions it would be almost a complete detail drawing. The only features that have not already been explained are the numbers which are given to the different members which are shown on this drawing. These numbers should be marked on the completed material when it is made in the shop, so that the erector will have no trouble in putting the material in place during erection, exactly as it is called for on this drawing.

It will be noticed that the sections which are seen on this drawing are not shown with the usual section lines, but all the lines are solid. This method is very often used in sectioning, and is as readily understood as any other. This drawing is a little unusual, however, as a much shorter method of showing exactly the same thing can be employed, and, as the whole purpose of drawings of this kind is to show the object or objects in as brief a manner as is consistent with clearness, the method shown in Fig. 61 is usually employed, and is to those who are familiar with it as clear and distinct as the drawing shown in Fig. 60.

Fig. 61 is what is known as a single-line drawing, and shows exactly the same material as is seen in Fig. 60, except the connections angles, which are not shown in the plan view, but which are shown in the sections of both drawings exactly the same. The only difference in these drawings is that Fig. 60 gives a complete top view, while in Fig. 61 only a single line is shown; but, as all the members are clearly named and the sizes and weights of the material are also given, it is not necessary to show a complete view in a drawing.

All the different classes of drawings relating to construction work have now been explained, and it is up to the reader to make good, and this can be accomplished by a little study. Go over each chapter and each illustration and think it all out, and you will find that it is very easy to master, and, if you master it, you will as you journey through life find that it will be one of the greatest assets which you possess.